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Contents of Volume 17, No. 2, 1980

PAGE

Prospects of fishery, utilization and culture of crabs in India

C. K. Radhakrishnan & C. T. Samuel 67

Cathodic protection of aluminium sheathed wooden fishing boats with ternary aluminium anodes

A. G. Gopalakrishna Pillai, K. Ravindran & R. Balasubramonyan 71

Effect of colour on the catch of gill nets

J. Sita Rama Rao, Percy Dawson & Y. Sreekrishna 75

Hydrography of fishing grounds of Arabian Sea off Mangalore

Mathew M. Maliel, P. K. Salian, N. R. Menon & H. P. C. Shetty 79

Standing stock of three species of demersal fishes from south west coast of India

Mathew M. Maliel, P. K. Salian, N. R. Menon & H. P. C. Shetty 87

Canning of Squid

P. R. G. Varma & Jose Joseph 93

Nutritional evaluation of an indigenous low cost protein food

Joy P. Chungath, K. Gopakumar, A. Vasanth Shenoy & R. Thankamma 95

Preparation of masmin—An improved method

V. Muraleedharan & A. P. Valsan 99

PAGE

Survey of the properties of master cartons (Corrugated fibre board boxes) used in frozen shrimp industry

T. K. Srinivasa Gopal & T. K. Govindan 103

Survey of the properties of waxed duplex cartons used in frozen shrimp industry

T. K. Srinivasa Gopal & T. K. Govindan 107

Salinity and survival of *Martesia striata* (Linn) in Cochin Harbour

P. V. Cheriyan & C. J. Cherian 111

Protein concentrate from shark

S. T. Chari & A. Sreenivasan 115

Fat and water contents of the muscle and gonad of *Otolithus argenteus* in relation to gonad growth

V. Vinayak & B. Neelakantan 119

Isolation of *Salmonella roan* for the first time in India

T. S. Gopalakrishna Iyer & A. C. Joseph 123

Frozen storage characteristics of ribbon fish

Rajendra Badonia & K. Devadasan 125

Preparation of edible powder from jawla *(Acetes* sp.) prawns

A. N. Mulbagal, S. N. Mahajan & A. M. Ranade 127

INDEX TO AUTHORS

Balasubramonyan, R.	71	Percy Dawson	75
Chari, S. T.	115	Radhakrishnan, C. K.	67
Cherian, C. J.	111	Rajendra Badonia	125
Cheriyan, P. V.	111	Ranade, A. M.	127
Devadasan, K.	125	Ravindran, K.	71
Gopakumar, K.	95	Salian, P. K.	79, 87
Gopalakrishna Pillai, A. G.	71	Samuel, C. T.	67
Gopalakrishna Iyer, T. S.	123	Shetty, H. P. C.	79, 87
Govindan, T. K.	103, 107	Sita Rama Rao, J.	75
Joseph, A. C.	123	Sreekrishna, Y.	75
Jose Joseph	93	Srinivasa Gopal, T. K.	103, 107
Joy P. Chungath	95	Sreenivasan, A.	115
Mahajan, S. N.	127	Thankamma, R.	95
Mathew M. Maliel	79, 87	Valsan, A. P.	99
Menon, N. R.	79, 87	Varma, P. R. G.	93
Mulbagal, A. N.	127	Vasanth Shenoy, A.	95
Muraleedharan, V.	99	Vinayak, V.	119
Neelakantan, B.	119		

The following papers appeared in the last issue of Fishery Technology

Contents of Volume 17, No. 1, 1980

	PAGE
Vibrio parahaemolyticus and the seafood industry R. Natarajan, Martin Abraham & G. Balakrish Nair	1
Estimation of fishery resources by sonar surveys K. Krishna Rao, S. Natarajan & G. P. Edwin Daniel	7
Eradication of uneconomical fishes with simple gill nets at Hirakud reservoir A. A. Khan, V. C. George & M. D. Varghese	15
Iced and frozen storage characteristics of cultured *Chanos chanos* (FORSKAL) Jose Joseph, P. A. Perigreen, Chinnamma George & T. K. Govindan	21
Utilization of frog waste A. Lekshmy Nair & P. V. Prabhu	27
Bacteriology of spoilage of canned prawns V. Narayanan Nambiar	35
Transportation of fish-iii. Biochemical changes in fish during transportation in insulated containers. P. R. G. Varma, A. P. Valsan & P. V. Prabhu	41
Purification and properties of aspartate aminotransferase (E.C. 2.6.1.1.) from skeletal muscle of *Cirrhina mrigala* S. K. Chhatbar & N. K. Velankar	43
Studies on aminotransferase enzymes in fish and shell fish. S. K. Chhatbar & N. K. Velankar	51
The triglyceride fatty acids from heart lipids of *Puntius sarana* and their variation with different sizes Rita Mitra & Ramji D. Dua	57
Penetration of sodium chloride during prolonged salting of fish D. Narayanaswamy, C. V. Narasimha Rao & T. K. Govindan	63
Column set gill net fishing in Gobindsagar reservoir A. A. Khan, N. A. George & O. P. Pandey	65

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Fish. Technol. (1980) **17**, 67-69

Prospects of Fishery, Utilisation and Culture of Crabs in India

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Investigations on the fishery, utilization and development of the crabs in Indian waters have been reviewed. Various factors relating to the improvement of fishery, keeping quality of the crab meat and possibilities for an integrated farming of commercially important crabs are discussed.

Though crab fishery in India is not recognised as a major one, the abundant occurrence of food crabs in the coastal and inland waters truly envisages the prospects of an export oriented fishery. The reason for the backwardness of this fishery may be attributed to the seasonal occurrence and low meat content of crabs. Crabs are confined to the narrow coastal belt and generally considered to be a cheap food.

The family portunidae includes the edible crabs such as *Scylla serrata* (Forskal), *Portunus pelagicus* (Linnaeus), *Portunus sanguinolentus* (Herbst) and *Charybdis crusiata* (Herbst). *S. serrata* is a typical estuarine form and grows to 150 to 300 mm carapace width and is the most preferred food crab. They are distributed largely in lakes, backwaters and mangrove swamps and breeds all round the year particularly in the inshore region.

P. pelagicus and *P. sanguinolentus* and *C. crusiata* are marine, breed throughout the year and fished extensively from the inshore waters by commercial trawlers. They grow very fast and attain 100 to 140 mm in carapace width.

Fishery

Important works on crab fishery are those of Rai (1933) on the shell fisheries of Bombay presidency, Hora (1935) on the bionomics and fishing methods of the edible crabs of lower Bengal, Chopra (1936, '39) on the biology of the food crabs of the Indian coast, Chidambaram & Raman (1944), and Prasad & Tampi (1951) on the fishery and fishing methods of crabs from the south east coast. Chacko & Palani (1952) studied the crab fishery of Ennur backwaters, Jones & Sujansingani (1952) included crabs in their study on the fishery of Chilka lake, Menon (1952) studied the fishery of *P. sanguinolentus* from Malabar coast, George & Nayak (1961) worked on the fishery of *P. sanguinolentus* from Mangalore coast, Rao *et al.* (1973) on the bionomics and fishery of the commercially important species of Indian coast, Mohanty (1973) on the landings of *S. serrata* from Chilka lake, Datta (1973) on the edible crabs of Deltaic West Bengal, Ansari & Harkantra (1975) on the crab fishery from Goa, Patel & Trivedi (1975) from Gujarat, Manohara Rao & Chandramohan (1978) from Mangalore and Radhakrishnan (1979) from Porto Novo coast.

The total crab landings (along with some other minor crustaceans) in 10 states for 6 years are presented in the Table 1. Crabs are exploited in appreciable quantities along the coasts of Gujarat, Maharashtra, Karnataka, Kerala, Tamil Nadu and Andhra Pradesh. Crabs are also available from the Gangetic delta, Chilka lake and the Ennur backwaters. The peak fishing season in Gujarat is from July to September, Maharashtra from August to October, Karnataka from December to January, Kerala from July to September, Tamil Nadu from March to June and October to December and in Andhra from April to September. A variety of fishing implements such as scoop nets, long line, cast nets and stake nets are used. *S. serrata* is caught chiefly by hook and line and other marine crabs are mainly collected by commercial

Table 1. *Annual landings of crabs and other crustaceans in tonnes from* 1973 *to* 1978*

Year	Kerala	Karnataka	Tamil Nadu	Andhra Pradesh	Orissa	Pondicherry	West Bengal	Maharashtra	Gujarat	Goa
1973	1,781	934	7,719	364	—	194	60	687	749	20
1974	2,886	1,742	9,752	934	—	201	45	973	5	86
1975	1,797	2,540	13,896	605	—	260	8	550	10	227
1976	1,316	156	16,413	329	23	516	—	51	224	971
1977	4,621	207	11,018	719	6	296	—	93	2,471	637
1978	2,176	741	9,290	477	4	251	—	148	584	531

*From Central Marine Fisheries Information Service

trawls operated in inshore and offshore regions.

There exists no well organised programme for the commercial exploitation of crabs in India and the fishery itself is seasonal and scattered. Fluctuations in the catch can be attributed to the mass movement of crabs to different biotopes, the extent and the cause of such movements and the dominance of one sex resulting in abnormal differences of sex ratio in certain periods need further studies.

Nutritive value and utilization

In India only scant information is available on the nutritive value of crabs. The investigations by Chinnamma *et.al.* (1970), Chinnamma & Arul James (1971) and Chinnamma (1973) on the common edible crab *S. serrata,* reveal that the maximum nutritive value is from October to March with a maximum meat content (30 to 35%) from September to December. The meat content varies with lunar phases. A mixture of ascorbic and citric acids is the best glaze to extend the shelf life of processed crab meat. Fresh frozen crab meat remained in good organoleptic condition for about 51 weeks at-23° C while iced and frozen ones only 21 weeks. Radhakrishnan & Natarajan (1979) observed more protein, less fat and carbohydrate in younger ones and *vice versa* in older ones of *Podophthalmus vigil.*

The nutritional value of the crab meat is not inferior to that of any other sea foods. From Table 2 it is evident that the demand for canned crab meat is on the increase, and an integrated research is particularly required on the utilization of crab meat, the seasonal variation of meat content, susceptibility to rapid spoilage and the observed colour change during processing.

Development and culture

There are no integrated and systematic studies on the development and culture of the edible species of crabs in India, except some fragmentary ones by Prasad & Tampi (1953) on the early zoea stages of *P. pelagicus* and *Thalamita crenata,* Naidu (1955) on the first zoea of *S. serrata,* Srinivasagom & Natarajan (1976) on the first zoea of *P. vigil.* There is an admissible dearth of information with regard to the complete life history of food crabs and the methods of culture in the confined areas of the estuaries.

Farming of the edible crab *S. serrata* has been undertaken on a large scale in Philippines

Table 2. *Annual export of canned crab meat**

Year	Quantity Kg	Value Rs
1973	18,712	3,84,339
1974	13,679	5,09,534
1975	2,763	1,05,545
1976	25,672	14,50,122
1977	50,118	31,43,914
1978	41,653	19,40,684

*From Marine Products Export Development Authority of India

by local fishermen. This species is cultured in ponds along with the milkfish *Chanos chanos* and harvested in the sixth month (Pagcatipunan, 1972). India with a network of highly productive inland water systems, has possibilities of commercial farming of *S. serrata*. The seeds of this species are available from the surface backwaters at night, especially during full moon. They are found to be actively feeding on bits of intestine and other soft parts of fishes, molluscs and crustaceans. In the natural environs adequate feeding may not be possible due to the competition for food, resulting in slow growth.

Crabs are pugnacious and cannibalistic. After moulting, the sponge crabs are prone to the attack of predators. The frequent loss of chelate legs and their repeated regenerations may retard the overall growth of the animal to some extent. Similarly the association of certain cirripeds such as *Octolasmis sp.* is very often observable in the gills of crabs. This association may not be pathogenic, but thick population of cirripeds may obstruct the function of gills. Also in the natural environment the crabs are frequently parasitised by *Saculina sp.*

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Fish. Technol. (1980) **17**, 71–73

Cathodic Protection of Aluminium Sheathed Wooden Fishing Boats with Ternary Aluminium Anodes

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Results of laboratory and field trials on cathodic protection of aluminium sheathing in fishing boats by ternary aluminium anodes are presented. The high negative potential of 1.06 V with respect to saturated calomel electrode, its appreciably low anodic polarisation and high current output are favourable factors for using the ternary aluminium anodes. The low rate of consumption of the anode material under service trials attests its economic viability.

Corrosion is a major economic problem in fishing boats. Mechanised wooden fishing boats in India are either sheathed with copper or aluminium magnesium alloy. But frequent escalation in the price of copper coupled with its limited availability have necessitated the substitution of an alternate, equally efficient, readily available and cheaper material. Consequent on the studies in this direction (Balasubramonyan, 1965; Balasubramonyan *et al.* 1968), the use of aluminium magnesium alloy in fishing boats has been recommended and over thousand boats are sheathed with the low cost aluminium magnesium alloy in the country.

Aluminium magnesium alloy (Indal M 57 S) owing to its high potential, occupies an extreme position in the galvanic series of metals and alloys in sea water. This alloy is prone to corrosion and adequate protective measures by using anticorrosive paints and supplementary protection by galvanic anodes are to be resorted to for achieving an economic life span. This paper highlights the studies carried out with ternary aluminium alloy in the laboratory and on a 15.24 m fishing trawler.

Materials and Methods

Laboratory experiments were carried out using 22 SWG aluminium alloys Indal M 57 S (Indian Aluminium Company, Calcutta), Hindal 5052 and Hindal 5086 (Hindustan Aluminium, Renukoot), Brass (70/30), mild steel and cupronickel (70/30). The composition of the three grades of

Table 1. *Composition of different aluminium magnesium alloys*

		Chemical composition (%)
INDAL M 57 S	Mg	2.0
	Cu	0.2
	Fe	0.2
	Mn	0.1
	Si	0.2
	Zn	0.1
	Cr	0.2
	Al	97.0
HINDAL 5052	Mg	2.2 to 2.8
Si +	Fe	0.45
	Cr	0.15 to 0.35
	Zn	0.20
	Cu	0.10
	Mn	0.10
Others		0.15
Remaining Al		
HINDAL 5086	Mg	3.5 to 4.5
	Fe	0.5
	Si	0.4
	Mn	0.2 to 0.7
	Zn	0.25
	Ti	0.15
	Cr	0.05 to 0.25
	Cu	0.15
Others		0.15
Remaining Al		

Table 2. *Composition and electrochemical characteristics of ternary aluminium alloy anodes*

Composition %	Open circuit	Ampere hour out put/kg		Current efficiency %
		Theoretical	Practical	
Zn 4 to 7	Potential V SCE	2860	1590	90–95
Sn 0.08 to 0.22 Remaining Al	1.06			

aluminium alloys are given in Table 1. Ternary aluminium alloy anodes (Indian Patent No. 129038) were used for laboratory and field trials.

The nominal composition and the electrochemical characteristics are presented in Table 2. Laboratory studies were conducted in natural sea water using metal panels of 15 x 10 cm after cleaning and degreasing as described by Champion (1952). The potentials of the metals with cathodic protection by ternary aluminium anodes were measured with respect to saturated calomel electrode using a D. C. microvolt meter (Philips model 6009). To minimise the potential drop during measurements the Haber Luggin tube was kept close to the test electrode. The potentials of the protected metals were recorded after 30 and 60 days interval.

Service trials were carried out for two years on MFV Sindhukumari (15.24 m OAL, Central Institute of Fisheries Technology) which undertook regular fishing voyages. The vessel was sheathed with M 57 S and the painting schedule consisted of a coat of wash primer followed by two coats of zinc chromate primer and a finishing top coat of antifouling paint.

The boat had a sheathed area of 93 m² which was protected with 12 kg anodes of type 1 and type 2 (Figs. 1 & 2). The anodes were fixed to the hull through iron inserts using galvanised iron screws. To ensure electrical continuity between the anodes and the hull, resistance measurements were made. The potential of the hull was kept at —1.0 V SCE (Ravindran & Balasubramonyan, 1973). To counteract the corrosion by the gun metal propeller (1040 x 580 mm), stainless steel shaft, mild steel rudder and

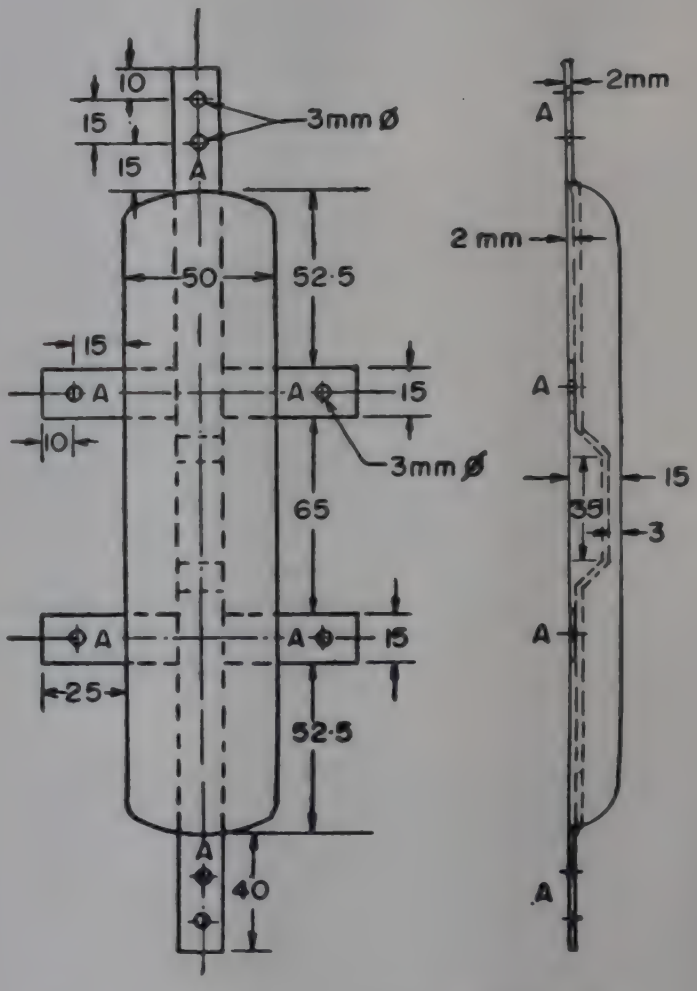

Fig. 1. Anode type 1. Ternary aluminium alloy anode
All dimensions in mm, A-mild Steel insert

cast iron shoe, 8 kg of the anodes were fixed at the stern area. The anodes and the hull were examined after 2 years.

Results and Discussion

The performance of different metals protected with the anodes is reported in Table 3, which shows that the potential of the cathode remained more or less constant indicating a steady driving potential and low polarisation of the anodes. The metals including

Table 3. *Performance of cathodes*

Metal	Electrolyte	Cathode potential volte After 30 days	After 60 days	Observations
Al (INDAL M 57S)	Sea water	–1.00	–1.00	Free from pitting and general corrosion
Mild steel	Sea water	–0.80	–0.80	,,
Cupronickel	Sea water	–0.35	–0.35	,,

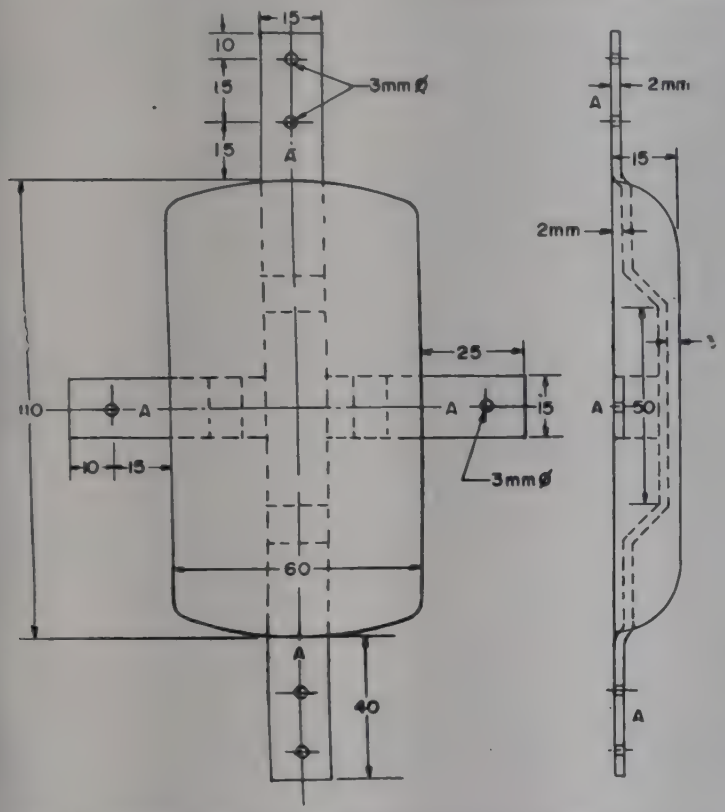

Fig. 2 Anode type 2. Ternary aluminium alloy anode. All dimensions in mm. A - mild steel insert

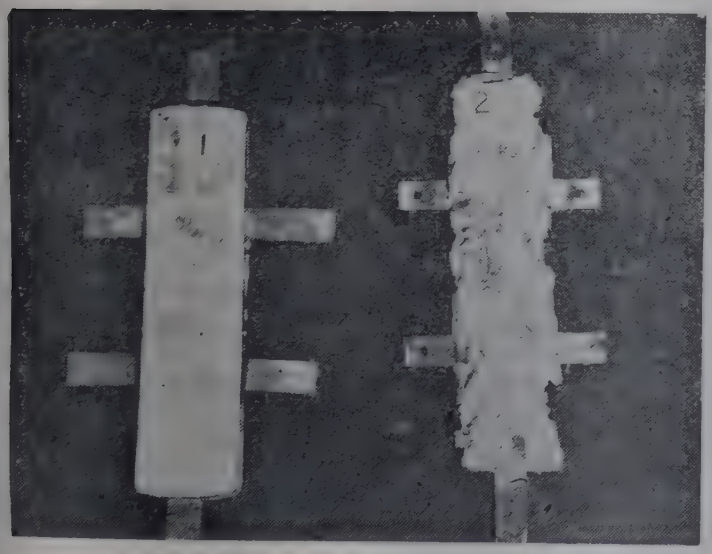

Fig. 3. (1) Anode before service trials
(2) Anode after service trials

aluminium magnesium alloys were all free from pitting corrosion evidencing cathodic protection by the anodes. The results also show that the anode could deliver current for long duration needed for cathodic protection.

The service trials provided further corroborative evidence on the effectiveness of the ternary aluminium anodes. Examination of hull, rudder, propeller and cast iron shoe after two years showed that they were free from pitting and general corrosion, whereas the wearing of the anodes, in certain cases to the extent of exposure of the iron inserts, evidenced the sacrificial action of the anode. The condition of the anode before and after use in the fishing boat is shown in Fig. 3. The consumption of the anode was 3.2 kg/100m²/year. The high negative potential of -1.06 V with respect to saturated calomel electrode together with an appreciable low polarisation while acting as anode as observed in the laboratory experiments and a low rate of consumption of the anode materials under service are factors which would favour the use of ternary aluminium anodes for cathodic protection in fishing boats. It is seen, that with the right choice of anodes both quality and quantity wise, the service life of this new sheathing material can be enhanced further.

The authors are thankful to the Director, Central Institute of Fisheries Technology for permission to publish this paper.

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Fish. Technol. (1980) 17, 75-77

Effect of Colour on the Catch of Gill Nets

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The effect of white, green, blue and yellow coloured drift gill nets on their catch with respect to *Scomberomorus guttatus* (Schneider), *Scomberomorus commerson* (Lacepede), *Scomberomorus lineolatus* (Cuvier), *Parastomateus niger* (Bloch), *Euthynnus affinis* (Cantor) and sharks *Carcharius melanopterus* is discussed. White nets were more effective for *S. guttatus* while the coloured ones caught more of *P. niger*. Blue had no significant effect for sharks. In the case of *S. lineolatus, S. commerson* and *E. affinis* no preference to colour was noted.

As the visibility of the fishing net in the water has an effect on its catch, many workers studied the effect of coloured nets (Nomura, 1959, 1961; Von Brandt & Liepolt, 1955; Andreev, 1958; Levy, 1964). Nomura (1961) noted increased catch in dark coloured nets during day with no effect during night. Andreev (1962) found that nets dyed with light colour did not fish well. Jester (1973) indicated that colour is species specific. Attempts have not been made in India to study the effect of coloured gill nets on catch. This paper reports the attempt of the authors to study the effect of coloured gill nets on the catch of seer, pomfret, tuna and sharks along the Andhra coast.

Materials and Methods

The material was polyamide white twine of Nm 34/3/3 with a uniform mesh size of 50 mm bar, undyed and dyed with green, blue and yellow. The twines were kept for 20 min. at 60°C in a 1% solution of neutral soap and ammonia (1:1). Subsequently it was kept in a bath with material to dye bath ratio 1:10 at a dye concentration of 0.1%. To this, acetic acid was added to get a pH of 3–4. The solution was heated to 60°C and the material after thorough washing and drying is introduced to the dye solution and heated to boil for 30 min. The material was taken out, excess dye solution was drained, washed and dried. Dyes used were manufactured by M/s. Sandoz (India) Ltd., Bombay. The net fleet had 16 units, the combination being four under each colour. Each net had 50 m mounted length and 6 m hung depth. The nets were operated in juxtaposition as surface drift at 20–65 m off Kakinada giving equal chances for all units.

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Results and Discussion

Table 1 shows that in general, white nets caught more of *S. guttatus,* while blue and yellow caught more of *S. commerson.* It is seen that for *S. guttatus,* variation between days and colours is significant at 1% level. Critical difference in catch was worked out to be 0.09365 with the mean logarithmic catch of the four different coloured nets as 0.4012 (white), 0.2411 (green), 0.1679 (yellow) and 0.2300 (blue). Accordingly white nets gave significantly higher catch in comparison with the other three, which were more or less similar in their catching rate. As regards *S. commerson* and *S. lineolatus* the variance between nets and days was not significant even at 5% level indicating similarity of catch rate in all nets (Table 1). As only limited number of these species were caught further experiments are necessary for confirmation.

The catching rate is different for different coloured nets (Table 2). *P. niger* was caught more in green nets, whereas *E. affinis* was relatively more in green nets followed by white and sharks in yellow. The chi.–square test (Table 2) reveals that in *P. niger* and sharks, the colour of the net has

Table 1. *Analysis of variance*

	White		Green		Yellow		Blue					
	no	wt	no	wt	no	wt	no	wt		SS	DF	MS	F
S. guttatus	69	71.95	39	43.00	26	34.05	38	40.90	Total	8.8956	143	—	—
									Between nets	1.0790	3	0.3563	8.67*
									Between days	3.5047	35	0.1001	2.47*
									Error	4.3218	105	0.0411	—
S. commerson	6	13.50	3	9.05	10	30.65	11	38.00	Total	1.9892	67		
									Between nets	0.1262	3	0.0421	1.30
									Between days	0.3112	16	0.0194	0.60
									Error	1.5513	48	0.0323	—
S. lineolatus	10	18.40	3	4.50	5	11.20	6	10.70	Total	1.3570	27	—	—
									Between nets	0.1722	3	0.0574	1.02
									Between days	0.1705	6	0.0284	0.50
									Error	1.0143	18	0.0563	—

* Significant at 1% level

Table 2. *Chi-square analysis for P. niger, E. affinis and shark*

	White		Green		Yellow		Blue		Calculated X^2	DF	Remarks
Species	no	wt	no	wt	no	wt	no	wt			
P. niger	69	52.00	119	72.13	102	65.77	113	71.99	14.78	3	$0.01 < P < 0.001$
E. affinis	59	97.30	63	106.20	49	86.10	40	63.60	6.08	3	$0.20 < P < 0.10$
Sharks	62	216.65	58	150.95	71	271.95	39	170.20	9.48	3	$0.05 < P < 0.02$

Table 3. *Chi-square analysis for P. niger and shark*

	Colour	X	DF	Remarks
P. niger	Green, blue and yellow	1.34	2	0.70 P 0.50
Sharks	White, green and yellow	1.39	2	0.50 P p.30

significant effect on the catch, but not in *E. affinis*. Hsiao (1951) while studying the response of five tunnies to artificial light by confining them in a tank illuminated with two 60 W bulbs and coloured lights of moderate intensity, observed that they were equally attracted by coloured and white lights. But Hsiao & Jester (1952) found that white lures were slightly superior to coloured ones, white was not significant to *P. niger* and blue to sharks and hence chi-square was applied for the three coloured nets leaving the one with less catch in the case of *P. niger* and sharks (Table 3). The chi-square test indicated that for *P. niger* the effect of green, yellow and blue was the same while for sharks white, green and yellow was equal.

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Fish. Technol. (1980) **17**, 79-86

Hydrography of Fishing Grounds of Arabian Sea off Mangalore

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Hydrographical parameters, namely temperature, salinity, dissolved oxygen and density of the fishing grounds off Mangalore extending over an area of *ca* 850 km² have been studied during March 1976–March 1977. Twelve stations along three transects up to 50 m isobath were located for sampling. The vertical distribution of temperature show three distinct phases, namely, a period of conspicuous variation, a short intermediary phase and a period of thermal stability. The dissolved oxygen of the bottom waters was drastically low during September. Salinity fluctuations were not considerable between months and depths. Dense waters existed over the shelf region, especially along the bottom during September and to a certain extent in October also. The distribution patterns of temperature, dissolved oxygen and density clearly indicate the movement of cold, dense, oxygen-poor bottom waters from greater depths to the upper reaches of the shelf during September.

Information on the hydrography of any area with reference to its direct bearing on fisheries should be an important aspect of fisheries hydrography. Probably, the work of Banse (1959) is an important step in this direction. His studies have shown that some direct correlations exist between the appearance and disappearance of demersal fishes and the hydrography of the west coast of India. Similarly, the importance of oxygen-minimum layer and its effect on the marine biology of the waters off the west coast of India were delineated by Carruthers *et al.* (1959). Pradhan & Reddy (1962) stressed the importance of temperature-salinity conditions to explain the fluctuations in the abundance of mackerel. Banse (1968), with documented evidence, tried to substantiate the concept that the hydrography of the Arabian Sea has a profound influence on the trawl fishery. Sankaranarayanan & Qasim (1968) found that the lowest fish and prawn catches in the Cochin area coincided with minimum temperature and oxygen content of the waters. Murthy (1969) attempted to work out a prediction system for pelagic fishery based on the mixed layer and the thermocline off the west coast of India. Noble (1972) observed a relation between the duration of mackerel fishery and surface temperature in the inshore waters off Karwar.

A few important works, although not directly treated under fishery hydrographic investigation, that could give detailed information on the hydrography of the west coast of India are those of Jayaraman *et al.* (1960), Ramamirtham & Jayaraman (1960), Neyman (1961), Ramamurthy (1963), Patil *et al.* (1964), Banse (1972), Sastry (1973) and Gangadhara Rao *et al.* (1974). These works provide information on hydrography in general, changes in the hydrographical structure brought about by the combined effects of monsoon and upwelling, distribution of oxygen-minimum layer in the surface waters and upsloping of isotherms.

Materials and Methods

The region explored covered 850 km² of the Arabian Sea along the coast of South Kanara, between Suratkal in the north and Someshwar in the south, extending up to 50 m isobath. The area investigated lies between long. 74′ 25°E & 74′ 51°E and Lat. 13°N & 12′45°N. Twelve sampling stations were distributed along three

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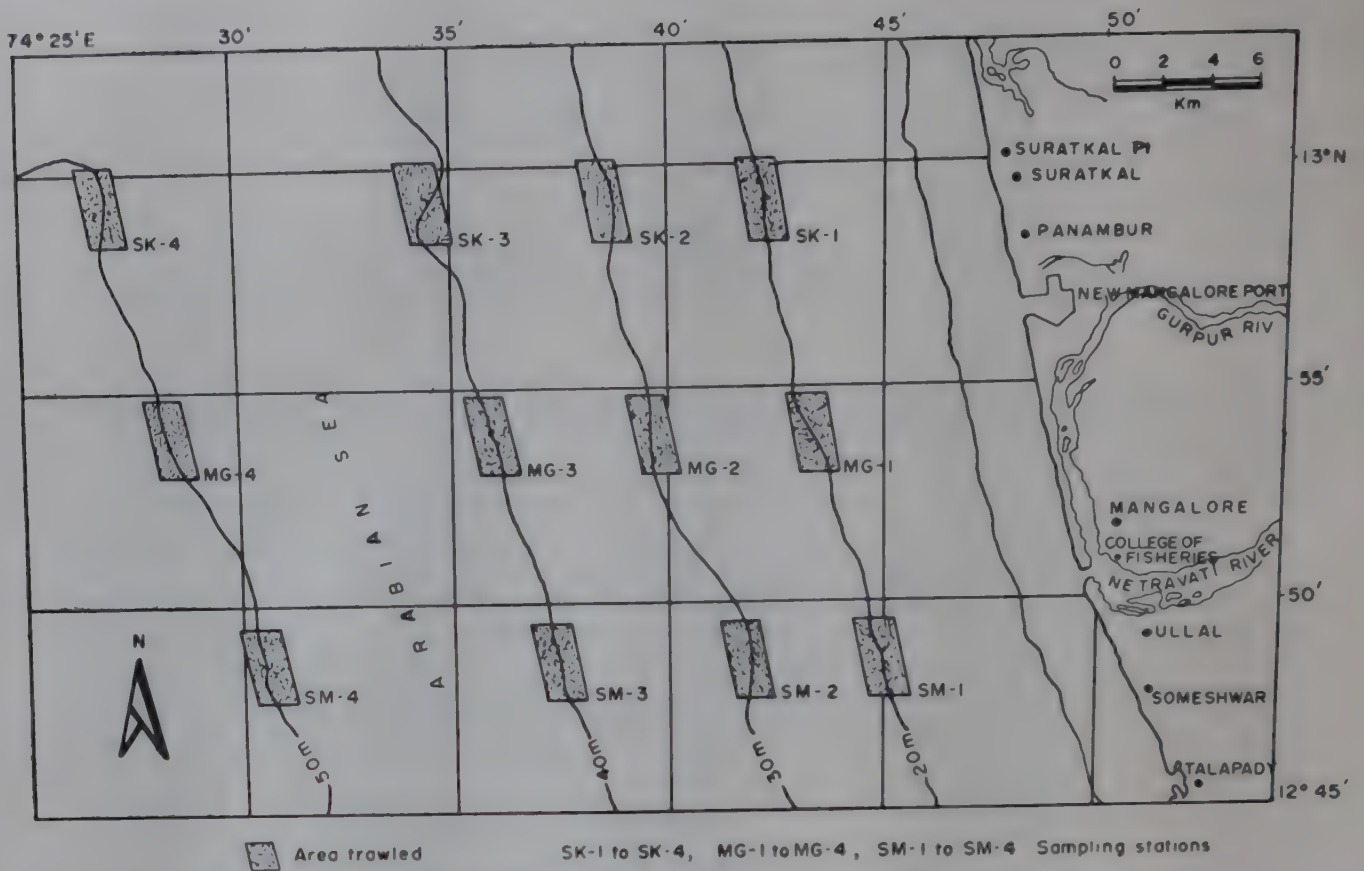

Fig. 1. Area of investigation showing the location of sampling stations

transects off Suratkal, Mangalore and Someshwar at four depth zones, namely, 20, 30, 40 and 50 m (Fig. 1).

The sampling started in March 1976 and concluded in March 1977. Owing to very rough weather, no sampling could be made during June, July and August. The 12 stations in the area were covered once in a fortnight by two sampling days. At each station water samples were drawn at 10 m intervals from surface to bottom. Subsurface water samples were taken with the help of a Nansen's reversing water bottle. Temperature was recorded with an ordinary mercury-in-glass thermometer immediately after tapping the water from the bottle. Salinity and dissolved oxygen were estimated following standard analytical procedures. Density of the water was computed.

Results and Discussion

Temperature of surface and columnar waters of the various stations distributed along the different transects is presented in Figs. 2a to 2c. It may be seen from the figures that comparatively cooler waters existed only during September. The lowest value recorded was 22.3°C at 20 m depth off

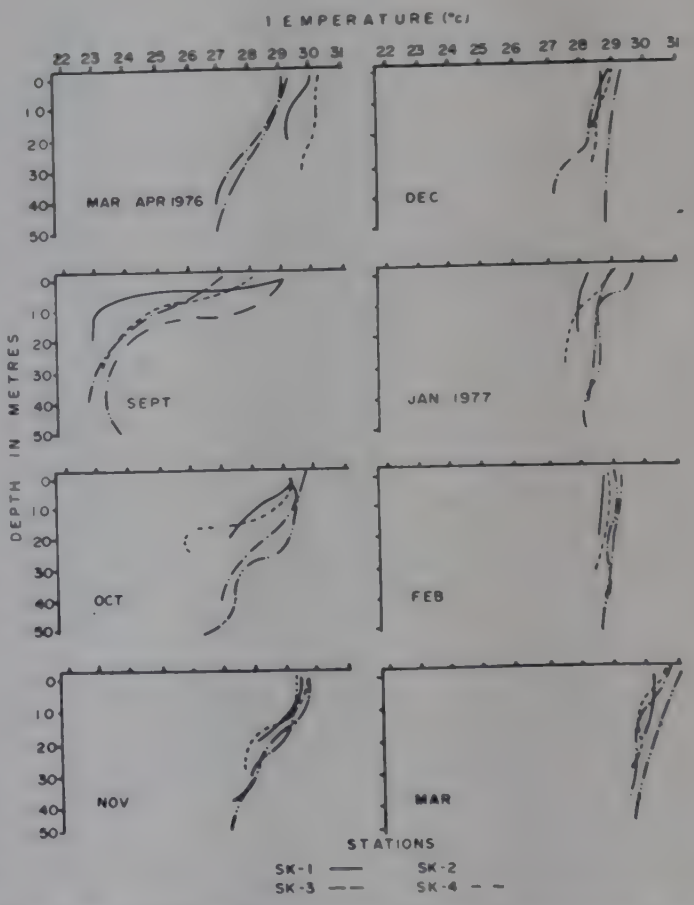

Fig. 2a. Vertical distribution of water temperature off Suratkal

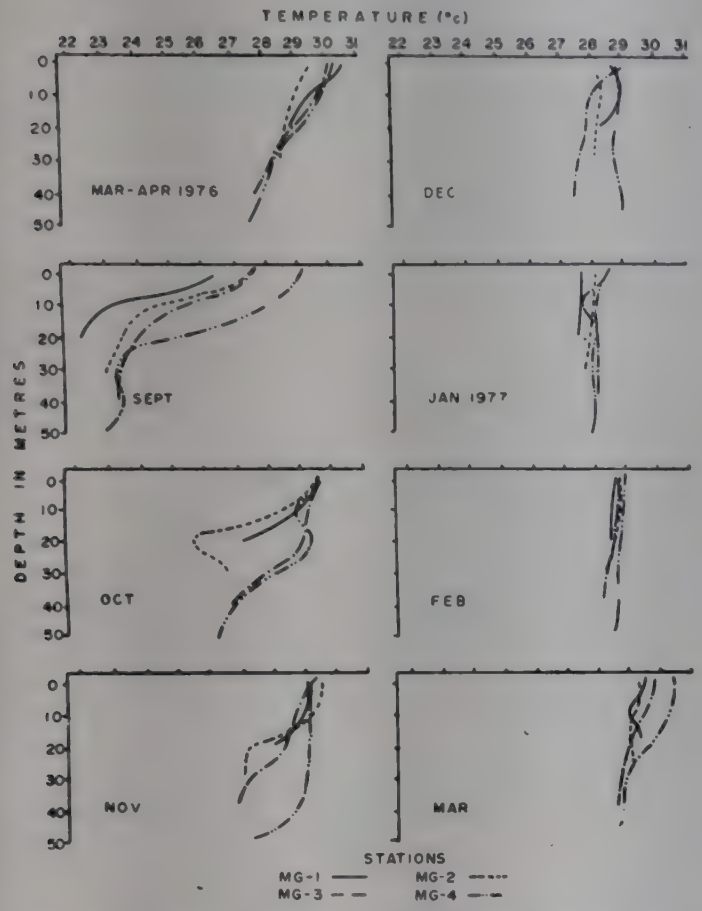

Fig. 2b Vertical distribution of water temperature off Mangalore

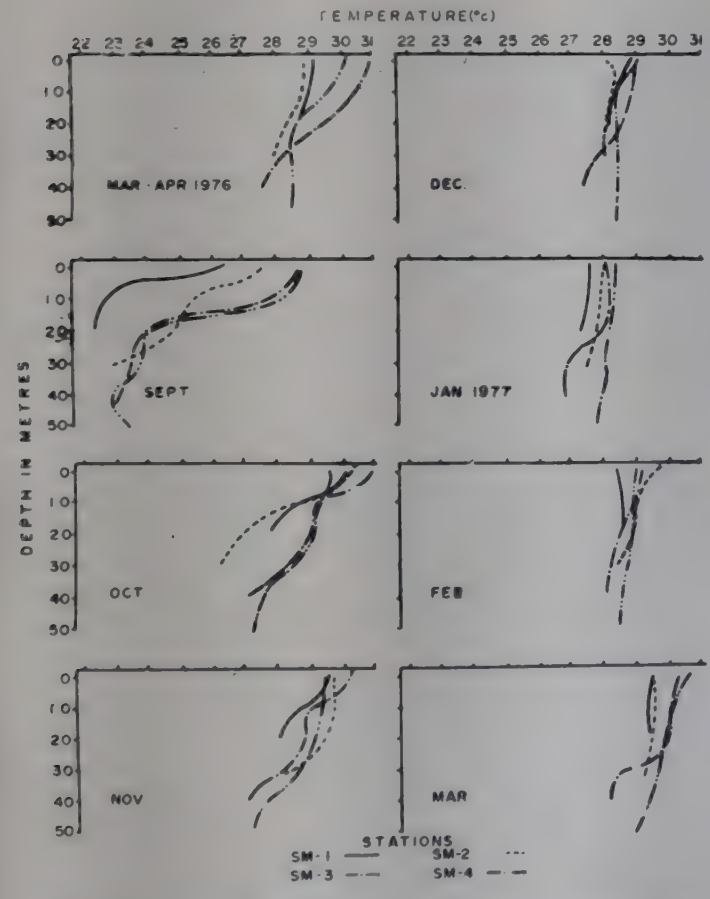

Fig. 2c. Vertical distribution of water temperature off Someshwar

Mangalore in September. The total fluctuation was 8.6°C which, considering the geographical location of the area, is conspicuous. It is clear from the figures that the premonsoon months showed very little fluctuation between stations or depths.

Distribution of salinity at the various depths along the three sections is presented in Figs. 3a to 3c. The surface waters of stations towards the coast showed only negligible reduction in salinity during September. A gradual increase in salinity was depicted towards the bottom. The nonmonsoon months experienced waters of higher salinity at all depths. It could be seen from the salinity figures that the premonsoon period, especially February, March and April, had lesser vertical gradient in salinity. Although the Mangalore and Someshwar sections are situated near the Gurpur-Netravati estuary, the freshwater run off does not seem to influence the salinity of deeper waters conspicuously.

Dissolved oxygen showed clear-cut seasonal and bathymetric variations is evident from Figs. 4a to 4c. The maximum range of variation was observed during September, when the bottom waters, particularly those beyond 20 m depth, had uniformly low values along all sections. In one instance during this month, a total lack of dissolved oxygen at 40 m depth off Suratkal was observed. The general reduction in oxygen at greater depths was found to continue at this area even after September. Oxygenation of deeper waters occurred only after a lapse of two to three months. The nonmonsoon months had well-oxygenated waters at various depths.

Denser waters were encountered at depths exceeding 10 m during September. The densities recorded for the various depths below the upper 10m during this month were decisively higher than those recorded for the rest of the period (Figs. 5a to 5c). The densities between the surface and deeper waters during October and November showed conspicuous variations at all the stations. The nonmonsoon months maintained a stable equillibrium evinced by less dense surface waters and denser bottom waters. Although variations in temperature was around 8°C and the salinity fluctuations were nearly negligible, the computed density

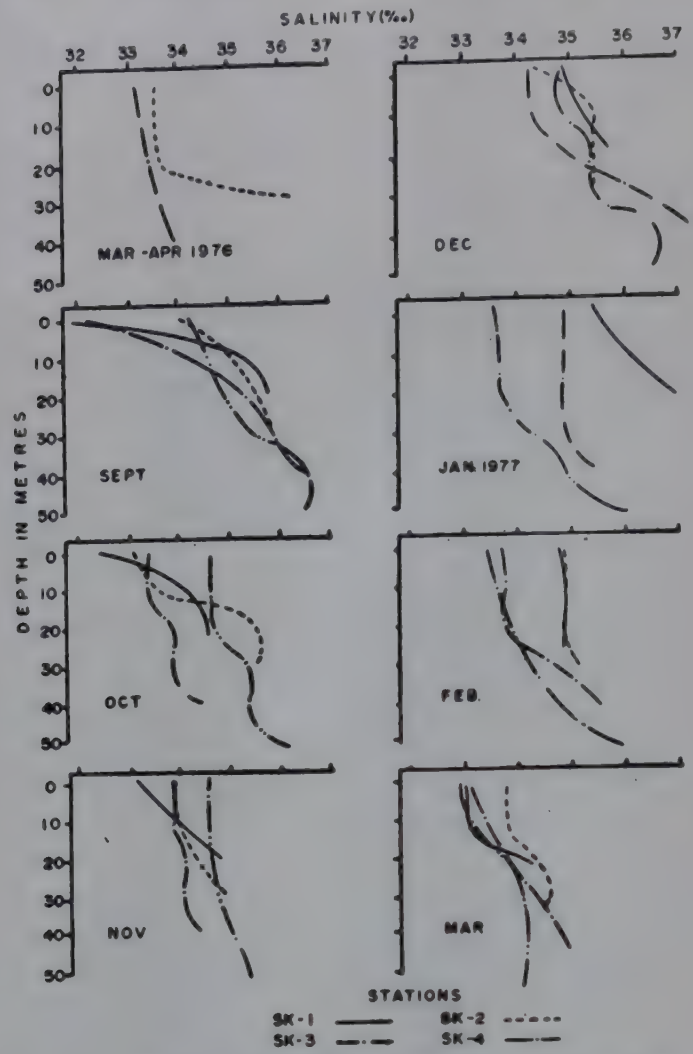

Fig. 3a. Vertical distribution of salinity off Suratkal

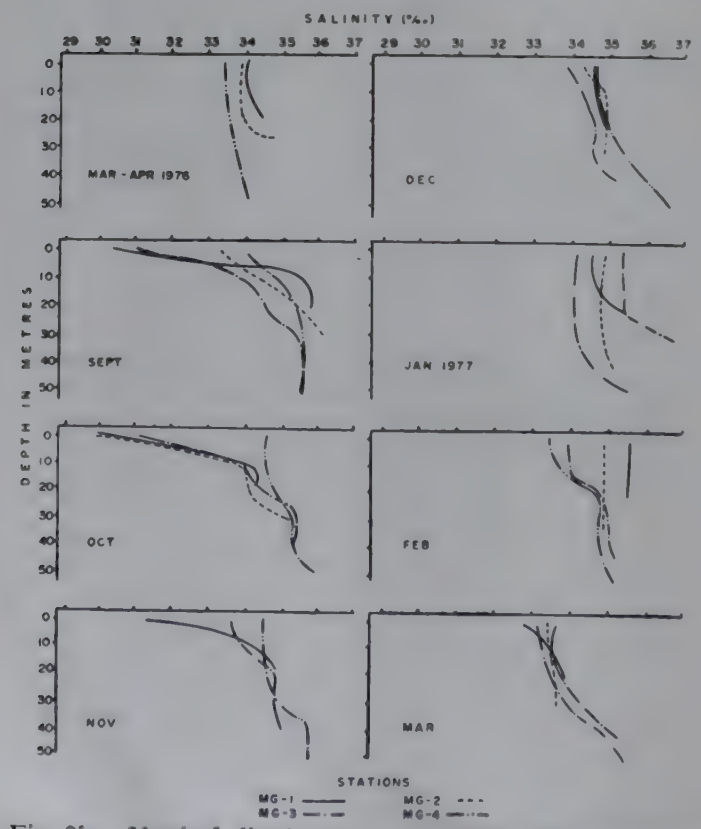

Fig. 3b. Vertical distribution of salinity off Mangalore

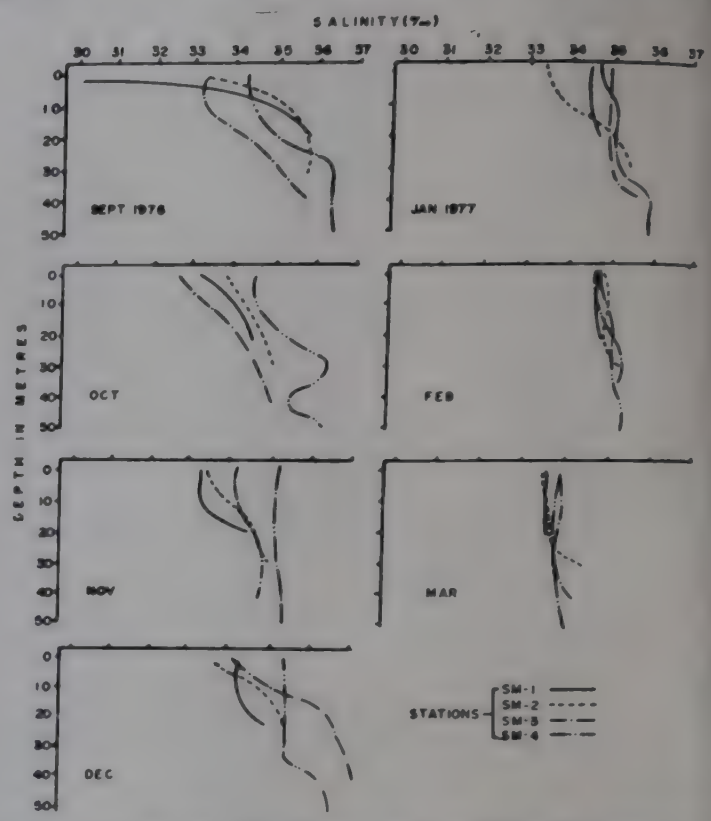

Fig. 3c. Vertical distribution of salinity off Someshwa

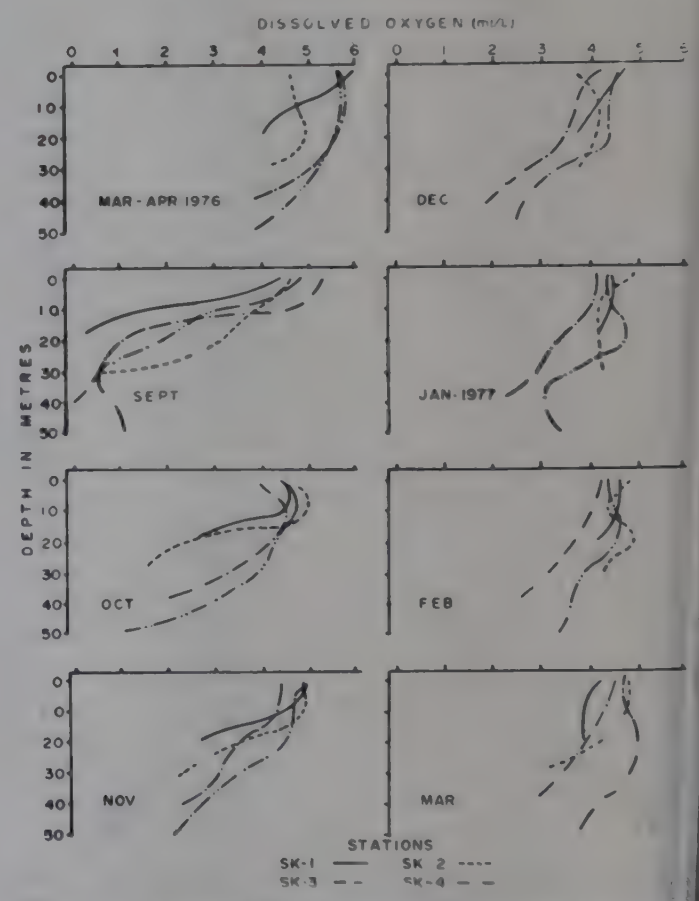

Fig. 4a. Vertical distribution of dissolved oxygen c Suratkal

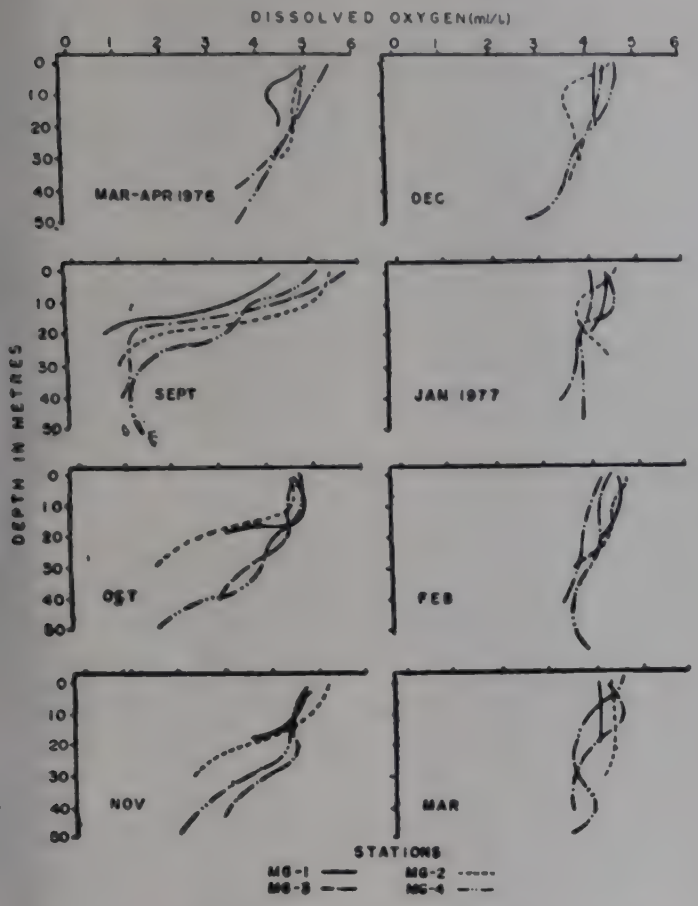

Fig. 4b. Vertical distribution of dissolved oxygen off Mangalore

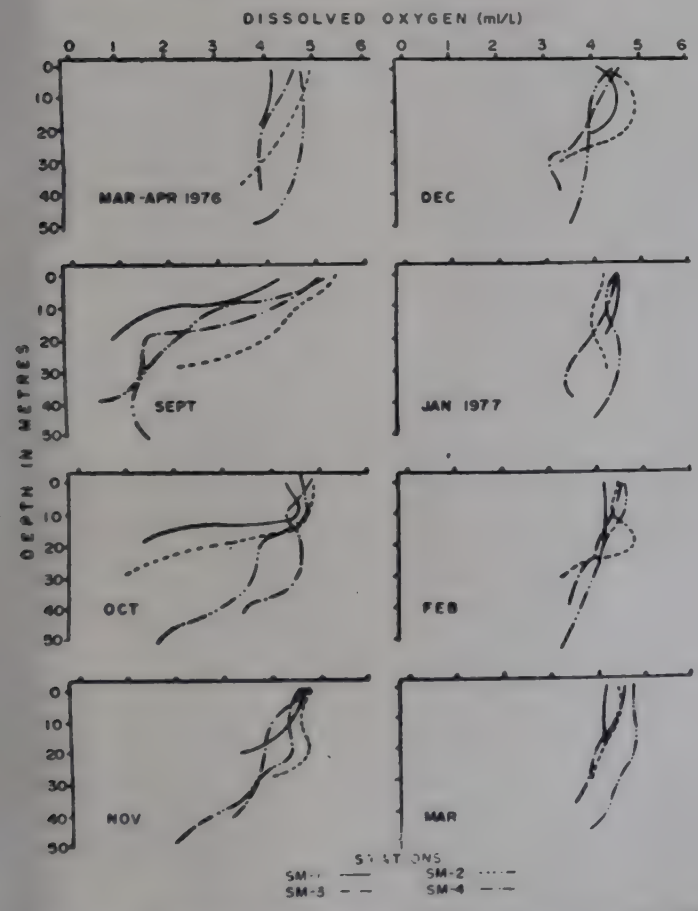

Fig. 4c. Vertical distribution of dissolved oxygen off Someshwar

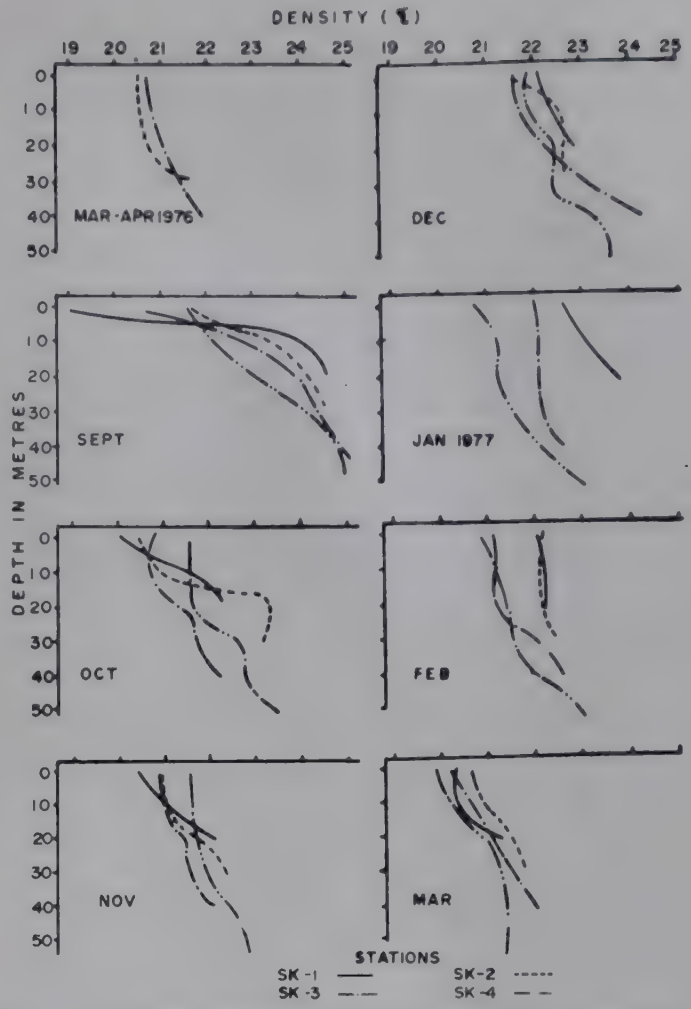

Fig. 5a. Vertical distribution of water density off Suratkal

values do show noticeable variations. It is probably implied that during September, October and November, denser waters from bottom are being transported towards the shallow regions of the continental shelf. The wide range of fluctuations in the vertical density structure of the waters in the monsoon and postmonsoon months clearly indicate conspicuous disturbances in the water body.

The vertical distribution of temperature shows three distinct phases, namely, a period of considerable variations in the vertical structure, followed by a period of thermal stability and an intermediary phase. Comparatively cooler waters existed even at shallow depths during September. September was conspicuous for temperature fluctuations from surface to bottom, may be due to cooling or entry of cold bottom waters from beyond the area of present investigation. It is possible that the cold water of the upper continental shelf is the remnant of waters upwelled under the influence of

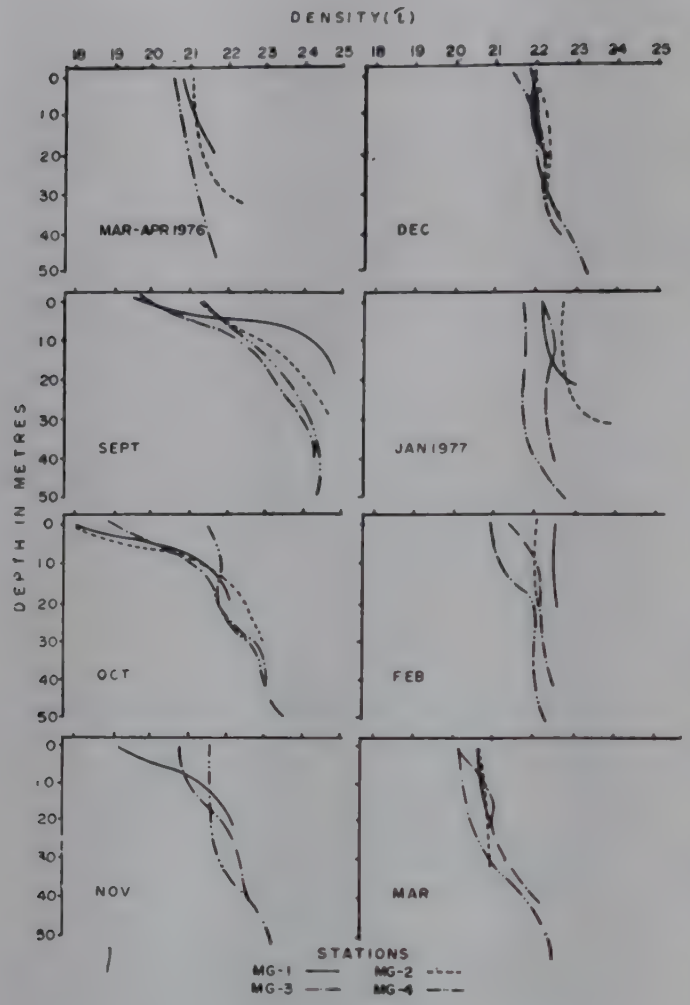

Fig. 5b. Vertical distribution of water density off Mangalore

southwest monsoon. Jayaraman & Gogate (1957) opined that under the influence of winds, the coastal waters assume the characteristics of off-shore waters owing to banking up. The fact that the surface waters get warmed up soon after monsoon, is in conformity with earlier observations (Seshappa and Jayaraman, 1956). Banse (1968) has stated that the upwelling which commences with the onset of southwest monsoon causes an uplift of the 20°C isotherm by 90–100 m. The presence of temperature gradients (3-4°C) at the top of the thermocline over intervals of less than 5 m, according to Banse (1968) suggests an active upward movement of deep water. Although comparable changes were not observed in the present study, the temperature gradient between 10 and 30 m at the deepest station during September was 5.5°C. Hence, it is logical to assume that at least at the deeper part of the upper shelf, there is considerable upward movement of water during September. It is of interest to note in this context that in the open shelf, however, a fairly deep surface layer overlies the cool bottom water during summer (Banse, 1968). The monsoon season forms a major part of the upwelling period. Ramamirtham & Jayaraman (1963) found the influence of cold waters in the Cochin area even during May. Ramasastry and Myrland (1959) felt that September is the period of upwelling along the southwest coast of India and that the subsurface water mass between 75 and 100 m in an undisturbed condition is drawn up to the surface.

The usual trend of decrease in the amount of available dissolved oxygen as depth increases was maintained in a uniform manner at almost all the stations. However, the range of fluctuations varied significantly between different months. Thus while the maximum vertical gradient was observed in September, when the surface waters had an average dissolved oxygen of 5.0 ml l^{-1} which narrowed down to 0.8 ml l^{-1} at the bottom, January, February and March showed an average surface value of 4.5 ml l^{-1} and at the bottom 3.7 ml l^{-1}. Banse (1968) stated that well-aerated waters were found up to the sea bed. This was found to be true in the present study also during March–April. Drastic decrease in oxygen of subsurface waters was observed in September, when in a few instances the waters contained absolutely no oxygen. Concentrations below 0.25 ml l^{-1} seem to be very common in the shelf area during this period. Curiously enough, Banse (1968) found total depletion of oxygen at depths ranging from 10 to 15 m off Bombay. He has remarked that oxygen depletion may be widespread below the thermocline. Extensive influx of bottom waters from areas below the compensation depth and entry of these waters to the upper shelf region, as evidenced by waters of very low oxygen even at 20 m, probably indicate that during the southwest monsoon period a distinct water mass exists in the upper shelf area of the west coast of India. It is not clear whether the presence of comparatively more oxygenated waters during October and November is an indication of withdrawal of oxygen-poor waters to deeper regions, or of high rate of oxygenation owing to enhanced primary production that invariably takes place during early postmonsoon.

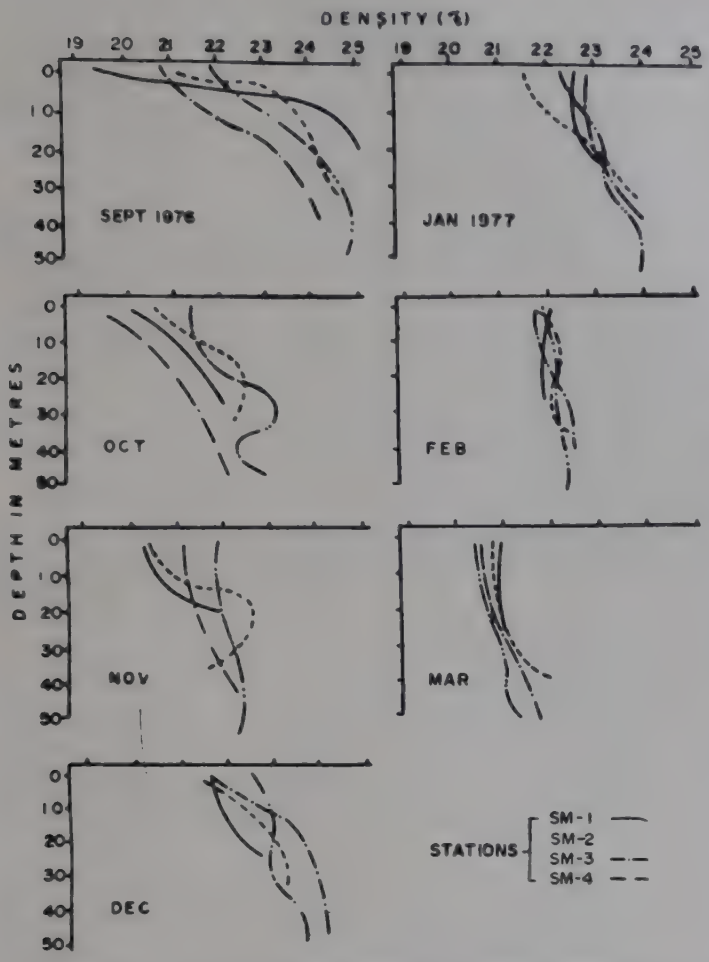

Fig. 5c. Vertical distribution of water density off Someshwar

The results clearly indicate that the change in the oxygen concentration of the water is a gradual process, and to have about 100 per cent saturation in the bottom waters the time taken can range up to four months. It has been proved recently (Anon, 1976) that during the southwest monsoon (May-October), the southward flowing current causes a lifting of the isolines of the various oceanographic parameters of coastal waters. This was pronounced during August-September when dissolved oxygen was as low as 0.5 ml l^{-1}.

The surface salinities in this area did not show noticeable difference during the monsoon months. Shah (1973) opined that the monsoonal effects by way of dilution will be felt only at the upper 5 m and that throughout the year the coastal waters will have typical marine condition below 5 m depth. Considering the amount of freshwater that is being discharged into the sea during monsoon by Netravati and Gurpur rivers, one is inclined to think that this run off will affect at least the surface salinities. But a perusal of the data clearly indicates that this was not so. A plausible explanation for this might be that the nearest station is situated around 10 km from the bar mouth. Gangadhara Rao *et al.* (1974) have observed that salinity, in general, increase towards offshore areas and with depth. However, the differences they observed were not radical. Sastry (1973) has worked out the temperature-salinity relationship at various stations in the Arabian Sea and he concluded that the salinity structure is quite complicated in the Arabian Sea, indicating mixing of water masses of varying T-S relationships. Hence, it is clear that aspects apart from the effects of monsoon should be taken into consideration when salinity structure of an area is interpreted.

The density distribution of the waters of the area clearly shows that denser waters prevail during September and to a certain extent during October and November also. Along with dense waters, in a few instances there appears to be isolated areas of less-dense waters at the surface. Such drastic changes in density between adjoining water masses is a common phenomenon during monsoon only. Interpreting the upsloping of density isolines during March–April, Varadhachari *et al.* (1974) have suggested the presence of upwelling along the coast of Mangalore-Karwar during this period. The present study has clearly indicated that the pattern of distribution of density along the coast of South Kanara is comparable with those obtained from the other parts of the west coast of India. It can be assumed that the major changes are being brought about during the southwest monsoon and the intensity and periodicity of this phenomenon might show spatial differences.

This work formed a part of the thesis submitted by one of us (Maliel) for his Master of Fisheries Science degree. He wishes to acknowledge the award of a UAS merit scholarship by the University of Agricultural Sciences, Bangalore.

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Fish. Technol. (1980) **17**, 87-91

Standing Stock of Three Species of Demersal Fishes from Southwest Coast of India

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Standing stock of three principal demersal fishes of the inshore waters off Mangalore was assessed. The assessment was based on fortnightly samplings conducted in an area extending over *ca* 850 km². The data gathered was computed employing Alverson's methods. The standing stock of *Nemipterus japonicus, Saurida tumbil* and *Grammoplites scaber* indicates that this area supports good quantities of these fishes and if properly exploited, will sustain a profitable demersal fishery.

Information on the standing stock of any species of fish contributing to a potential fishery is of immense importance for proper planning and exploitation of the resources. Estimations of standing stock are dependent to a great extent on theoretical values and subjectivity in analysis (Alverson, 1967) and further, it is not possible or not expected to make a thorough sampling of representatives of the stock distributed over wide areas. The extreme patchiness of the shoals, the mobility of the fish and their tendency to avoid vessels, may invalidate the results of the quantitative acoustic survey on the stock. Working on the stock assessment of *Sardinops ocellata* in the southeast Atlantic, Cram & Hampton (1976) have suggested that these survey errors can be reduced considerably by employing an aerial/acoustic strategy where the aircraft locates and measures the shoal area and the vessel makes synchronous measurements of the thickness and packing density from as many shoals as possible. The combined data may be expected to provide a direct estimate of the stock size. The recent publications by the UNDP/FAO Pelagic Fishery Project in Cochin (Anon, 1976) have taken into consideration mainly the data obtained by acoustic methods and supplemented with the results of aerial surveys. High resolution echosounders coupled to echo-integraters are used to locate and quantify fish shoals, followed by a mathematical computation of the available stock. This has proved to be useful and sufficient to give a more or less truthful picture of the standing stock. Even though this technology is infinitely faster and convenient, it is still not a perfect one, particularly in the tropical seas where multiplicity of species poses problems in the interpretation of data. Usually, an assessment of standing stock by direct methods of survey will not give any information on recruitment. Therefore, it should be supplemented with a detailed knowledge of biological aspects, such as breeding habits, development, growth, size and age at maturity and migration of the concerned species. Another important institution in India which has worked out estimations of standing stock, particularly of demersal fishes, is the Exploratory Fisheries Project of the Government of India.

A direct computation of the stock by way of sampling demands precise data on area trawled, the efficiency of the gear, period of investigation and the catch statistics. Therefore, data collected from landing centres, which seldom provide the above details, will not be of much use in the estimation of standing stock. Since during the present investigation these aspects could be followed critically to a great extent, it was possible to make attempts to assess the standing stocks of three most dominant demersal fishes of this area, namely the threadfin bream *Nemipterus japonicus*, the lizard fish *Saurida tumbil* and the flathead *Grammoplites scaber*.

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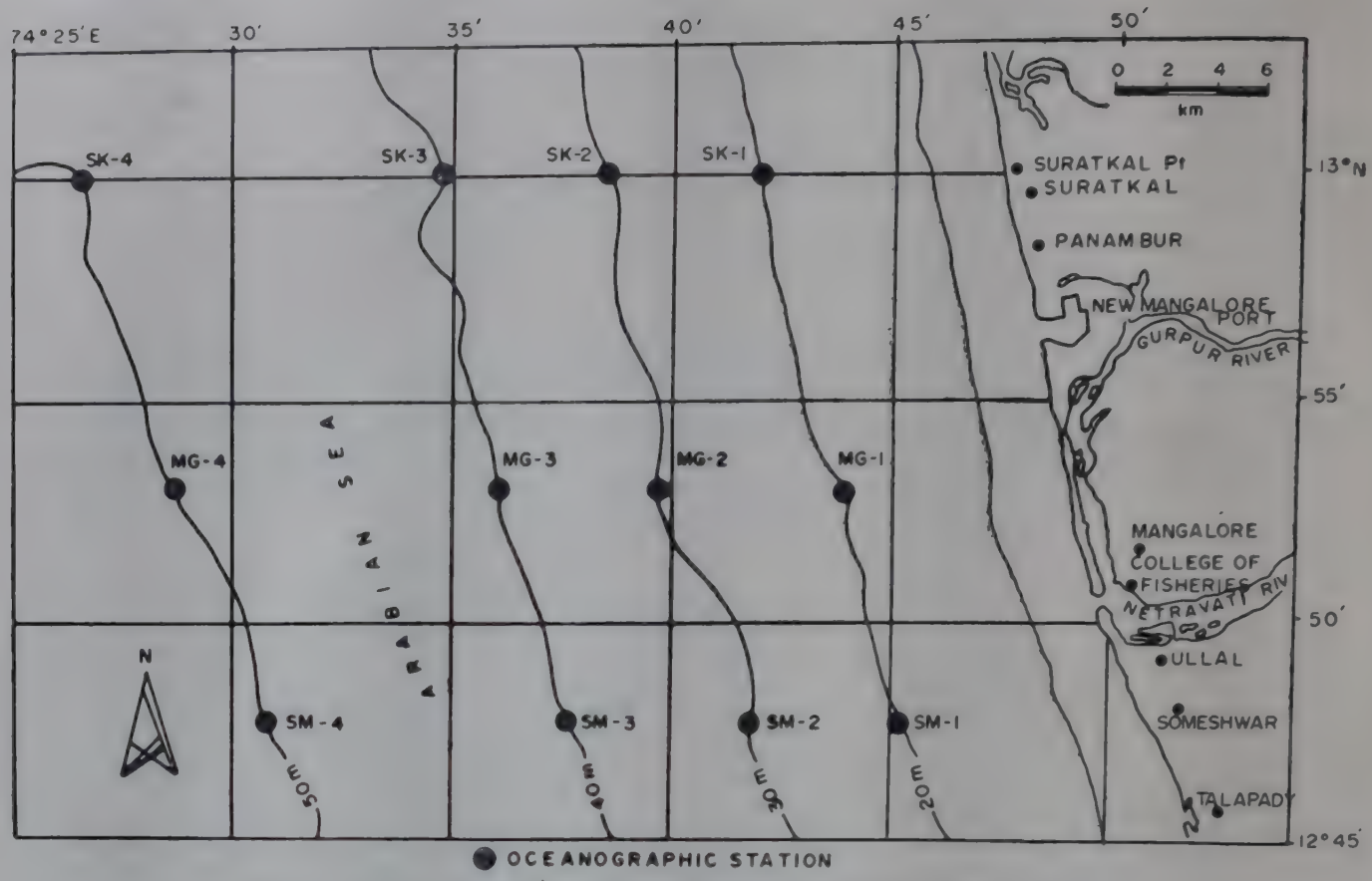

Fig. 1. Area of investigation and location of oceanographic stations

Materials and Methods

The region investigated covers a water-spread area of about 850 km² of the Arabian Sea along the coast of Mangalore, between Suratkal in the north and Someshwar in the south, extending up to 50 m isobath. This area lies between Long. 74° 25′E and 74° 51′E and Lat. 13°N and 12° 45′N (Fig. 1). Within this area, 12 sampling stations were fixed at four depth zones (20, 30, 40 and 50 m) along three sections.

The cruises were made with the help of a stern trawler, MFV *Dolphin* of the College of Fisheries, Mangalore. The specifications of the vessel are as follows: LOA 13.26 m, LWL 11.79 m, beam 3.76 m, mean draught 1.17 m and displacement 18.5 tonnes, fitted with Ruston 6 YDAM MK II engine capable of developing 102 bhp at 1800 rpm.

Throughout the period of investigation, bottom trawling was carried out employing a four-seam trawl of standard commercial design at all the stations. The trawl gear had a headline length of 39.2 m, stretched length of the net being 40.5 m and mesh size at cod-end being 30 mm. The average sweep of the trawl was empirically estimated to be 12.4 m based on the relationships suggested by Kostyunin (1971) and Fridman (1973). The vertical opening of the trawl mouth was approximately 2.5 m. The constructional details and dimensions of the trawl and otter board are given in Fig. 2.

Fortnightly samplings over eight months from March 1976 to March 1977, embracing the postmonsoon and the premonsoon periods, were made at the different stations. During monsoon, sampling was found to be impossible owing to rough weather and limited facilities at disposal. Usually trawling was done between 7 a.m. and 3 p.m. Each time the trawl was dragged for a period of 60 min. at 1.8 knots, covering an average distance of about 3.3 km and an area of approximately 0·041 km² of the continental shelf. The net was invariably dragged parallel to the coast at a constant depth. The direction of trawling was reversed every fortnight to nullify the effect of any error that might have crept in due to the differences in the time of sampling. The catches were analysed on board the vessel for species composition, species-wise weight and total weight.

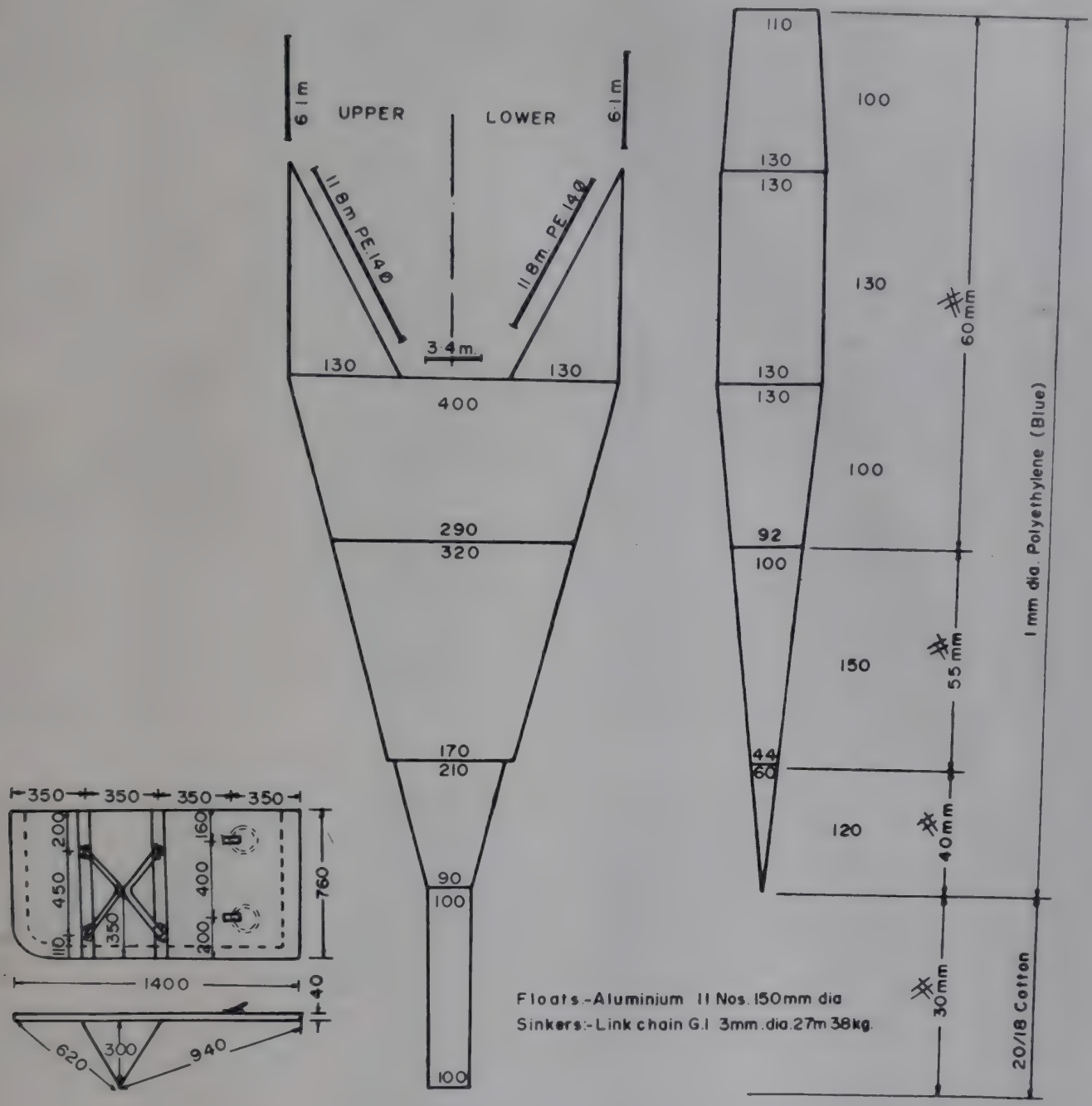

Fig. 2. Four seam trawl and otter board used in the study

The technique described by Alverson (1967) was employed to determine the standing stock. The method is founded on the basic assumption that catch per unit of effort is a function of the average stock density in the area being surveyed (Ricker, 1940; Gulland, 1964) and that the changes in the catch per unit of effort are directly proportional to changes in density. The formula adopted for the variance of effort is identical to that used by Cochran (1963).

Results and Discussion

The three species of demersal fishes, whose standing stocks have been estimated, together formed around 48% of the total catch. *Nemipterus japonicus* constituted 28.6% while *Saurida tumbil* and *Grammoplites scaber* constituted 10.9% and 8.7% respectively. The total weight of each of these species, the catch per hour and the details of estimation of the standing stock are presented in Table 1.

It is clear from Table 1 that populations of *N. japonicus* were more dense than those of the other two.

The estimated standing stock of this species was 3 x 10^5kg. The 90 per cent confidence limits were 2.3 x 10^5 and

Table 1. *Estimated standing stocks of the three most abundant demersal fish in the inshore waters off Mangalore, based on exploratory fishing survey data*

Stock assessment particulars	*N. japonicus*	*S. tumbil*	*G. scaber*
No. of hauls (n)	96	96	96
Hours fished (f)	96	96	96
Total catch (C), kg	1371.3	524.5	415.7
Average catch per hour (cpue), kg	14.3	5.5	4.3
Estimated standing stock (SS), kg	3×10^5	11×10^4	9×10^4
Variance of C ($\hat{V}$ (C))	416	56.71	25.21
Variance of f ($\hat{V}$ (f))	0	0	0
Covariance of C, f (Cov (C,f))	0	0	0
Variance of cpue ($\hat{V}$ (cpue))	4.30	0.59	0.26
Standard deviation of SS ($\sqrt{\hat{V}(SS)}$), kg	4.3×10^4	1.5×10^4	1×10^4
90% confidence interval of ss ($SS \pm 1.6\sqrt{\hat{V}(SS)}$), kg	2.3×10^5 to 3.7×10^5	8.5×10^4 to 13.5×10^4	7.4×10^4 to 10.6×10^4

3.7×10^5 kg. This species was followed by *S. tumbil,* whose standing stock was estimated at 11×10^4 kg, with 90% confidence limits at 8.5×10^4 and 13.5×10^4 kg. *G. scaber,* the least in abundance among the three, had a standing stock of 9×10^4 kg. The limits were 7.4×10^4 and 10.6×10^4 kg, at 90% confidence. These estimations are for an area of 850 km² of the sea bed off Mangalore.

There is no published evidence which suggests that species exploited by the Mangalore trawl fishery are being overfished in the biological sense. In fact, the effects of fishing on most species are unknown, as data to evaluate man's impact on stocks are laking for most species. The exploitation of any stock is largely determined by economic considerations. Whether or not be stock levels are above or below those of maximum sustainable yield is not known because of insufficient knowledge of fishery biological parameters.

The present findings indicate that a considerable amount of these three demersal species are available in the inner shelf off Mangalore. Considering the area sampled and the results obtained, it appears that a profitable fishery of these three fishes exists in this region. If it is to be assumed that comparable conditions are existing along the inner shelf region of the west coast of India, these ground-fishes will be a potential source of exploitation.

It is well known that estimation of standing fish populations are subject to considerable limitations. The results could be vitiated, since the organisms involved are quick moving and to a great extent migratory. Probably, estimates which would be near to reality will be those of sedentary benthic populations. Since the sea is an ecosystem of heterogeneity and variability, even the application of the most exact mathematical models might yield only rough estimates. The harvesting of one kind of organism might affect the subsequent replacement rate not only on the direct feedback mechanism built into the species itself, but also through the complex inter-relationships in the real trophic sense (Schaefer, 1954).

Further, the vertical distribution pattern of the fishes caught is another important aspect. The vertical opening of the bottom

trawl is confined to a restricted height just above the sea bed. If the species studied are capable of certain amount of vertical movement which might be time-or food–dependent, the amount taken from any particular region at a defined time might vary. The actual density gradient for demersal fishes above the bottom is unknown. Besides, undoubtedly, a considerable segment of the demersal fish population in the path of a trawl net is capable of avoiding or escaping it. The extent of effect of trawl sweeps or bridles on concentrating fish in the path of the net is unknown. These factors seldom find a place in a mathematical model. Probably, intensive sampling can help in reducing the degree of variability in assessment. Notwithstanding all these limitations, attempts are being made the world over to estimate the magnitude of standing stocks for proper management, conservation and prediction of the concerned fishery.

One of us (Maliel) is thankful to the University of Agricultural Sciences, Bangalore for the award of UAS merit scholarship, during the tenure of which the present work was carried out.

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Fish. Technol. (1980) **17**, 93-94

C.F.T.R.I.

Canning of Squid

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A simple method for canning squid *(Loligo sp.)* is discussed. Hot blanching the dressed meat in 7% brine containing 0.2% citric acid for 5 min, packing and subsequent filling with 2% brine containing 0.2% citric acid and processing at 1.0 kg/cm² steam for 20 min gave an excellent canned product with good shelf-life.

Squid *(Loligo sp.)* is caught in very large quantities in our country. Recently there has been an upward trend in the export of frozen squid (Table 1). Jose Joseph *et al.* (1977) have studied in detail the changes in the quality of squid meat during iced and frozen storage. The present paper describes a method by which squid meat can be canned and preserved for a long time.

Materials and Methods

Squids soon after collection were immediately iced and brought to the laboratory, beheaded, gutted, skinned and the meat thoroughly washed in potable water, hot blanched in brine, cut into ring forms, packed in SR lacquered cans (301 x 206), filled with brine, exhausted, seamed and sterilized at 1.0 kg/cm² steam and cooled in potable water. After surface drying, the cans were stored at room temperature. The sterility of the canned product was determined using thioglycollate test, as described in Difco Manual (1971). The cans were drawn periodically and were analysed for organoleptic characteristics to assess its shelf-life.

Results and Discussion

Initial trials of blanching with different concentrations of brine showed that the use of 7% brine gave an acceptable salty flavour to the blanched meat. Increase of brine concentration above that limit imparted too much salty taste, 7% brine was fixed as the optimum brine concentration. Varma *et al.* (1969) observed that constancy in drained weight can be obtained by adjusting the blanching time. Therefore different blanching times, 3, 5 and 7 min were tried to get a canned product with constant drained weight. With 3 min blanching there was a decrease in drained weight. Moreover the filled brine showed some turbidity due to the release of some soluble proteins from the meat during subsequent processing. But with 5 min blanching, the drained weight remained constant and the filled brine cleared. With further increase in blanching time, drained weight increased owing to the initial over-blanching of the meat. Processing at 1.0 kg/cm² steam resulted in a commercially sterile product as determined by the thioglycollate test.

Table 2 presents the changes in the canned product during storage at room temperature. This product had a slight soft texture. The texture improved by incorporating an optimum level of 0.2% citric acid in blanching brine. Another defect noticed during storage was blackening of the meat, and was prevented by incorporating citric acid in filled brine. The same phenomenon has

Table 1. *Export of frozen squid/cuttle fish from India**

	Quantity Tonnes	Value Lakhs of rupees
1973	14	1.90
1974	141	19.79
1975	1017	290.72
1976	648	133.34
1977	607	65.01
1978	2427	326.80
1979	2107	280.30

*Based on 'Statistics of Marine Products Exports" Published by Marine Products Export Development Authority, Cochin

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Table 2. *Organoleptic characteristics of canned squid during storage at ambient temperature*

	Immediately after canning		After storage at room temperature for 1 year	
Organoleptic characteristics	Without citric acid	With citric acid	Without citric acid	With citric acid
Colour	Good	Good	Poor, blackened	Good, no blackening
Flavour	Good	Good	Poor	Fair
Texture	Fair, slightly soft	Good	Rubbery	Fair

Table 3. *Intensity of blackening in canned squid during storage at ambient temperature*

	Squid meat packed in brine	
Period of storage months	With citric acid	Without citric acid
0	No blackening	No blackening
1	,,	,,
2	,,	Appearance of black spots
4	,,	Very slight blackening
6	,,	Slight blackening
10	,,	More blackening
12	,,	More blackening

been observed by Nandakumaran *et al.* (1970) in canned prawns. An optimum level of 0.2% citric acid in the filling brine was found to be necessary to maintain a titrable acidity of 0.1–0.15% in the final product which will prevent blackening.

Blackening was noticed in squid, canned without any citric acid from the second month of storage and the intensity of blackening increased with increased storage period (Table 3).

The authors are thankful to Shri G. K. Kuriyan, Director for his kind permission to publish this paper.

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Fish. Technol. (1980) **17**, 95-97

Nutritional Evaluation of an Indigenous Low Cost Protein Food

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A study of supplementary feeding was conducted on children with a protein food (edible fish powder in the form of 'chutney') for 35 days and the effect assessed periodically. The most noticeable effect was gain in weight and mid arm circumference in children. 35 % children showed a weight gain of 1 kg, 27% 0.5 kg, 21% 1.5 kg and 2.5% 2.5 kg. 48% children registered an increase in their mid arm circumference by 0.5 cm, 16% 1 cm and 2.5% 1.5 cm. 10% children did not gain weight. However, these children had intercurrent infections like measles, whooping cough and asthma.

Malnutrition, infection and infectious diseases are responsible for 95% mortality in children below 6 years in the developing countries (Gupta, 1977). Malnutrition in a child during the first year has an adverse effect on subsequent learning and behaviour (FAO/WHO, 1967). The Joint FAO/WHO (1971) Expert Committee has recommended special protein foods and energy requirements for the vulnerable groups, adults and children suffering from malnutrition. Udani (1975) stressed the need for developing suitable feeds for infants and pre-school children.

The improvement in the nutritional status of the young pre-school children is mandatory and an increasing need is felt for the development of a food, rich in protein and other nutrients palatable to children, economically feasible, technically advisable and socially acceptable. The Indian peninsula is gifted by a very long coast line of 6100 km with an annual marine fish landings of 1.32 million metric tons. Of them, more than 30% is composed of cheap miscellaneous fishes. However, these trash fish form a rich source of protein of high nutritional value. An attempt was made in this study to prepare a protein rich, cheap and palatable food for the pre-school children and feeding trials were conducted to find out the practical and nutritional implications.

Materials and Methods

The study was conducted at Vimalalayam, a social institute at Cochin, during November and December, 1977. The age of the children varied from 1 to 5 years. 950 children were examined and those suffering from serious illnesses and major congenital defects were excluded. Only 150 children who could attend this supplementary feeding programme regularly were chosen for the study and examined fully after recording the relevant clinical history. The children were fed with usual food at home, thereby assuring that the feeding was only supplementary and not substitutory. The feeding was between 3 and 4 p.m. every day.

The edible fish powder was prepared out of lean fish meat. The meat was cooked, pressed in canvass bags and dried in an electrical drier. The dried meat was powdered, sieved and packed 1 kg each in polythene bags, subjected to detailed bacteriological analysis and care was taken that every sample was free of all pathogens. Proximate composition (Table 1) of the fish powder was determined by the methods of AOAC (1960). Amino acid composition was determined micro-biologically (Kavanagh, 1963; Gopakumar, 1973). The fish powder 'chutney' was prepared by mixing the ingredients in the ratio as given in Table 3

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and grinding it to a paste in a mechanical grinder. Each child, irrespective of age, was fed with 40 g of 'chutney' (containing 20 g protein) with two slices of bread or a few pieces of cooked cassava.

Table 1. *Proximate composition of fish powder*

Protein %	80.5
Ash %	9.5
Moisture %	5.3
Fat %	4.7

Table 2. *Amino acid composition of fish powder*

Amino acids	g/100 g of fish powder
Lysine	7.10
Valine	6.56
Arginine	3.10
Methionine	3.24
Tryptophan	1.20
Isoleucine	5.52
Tyrosine	5.76
Cystine	0.28
Aspartic acid	7.06
Proline	7.70
Serine	6.40
Histidine	1.82
Leucine	6.00
Threonine	4.70
Phenylalanine	4.55
Glycine	1.15
Glutamic acid	13.50

Table 3. *Composition of 'chutney'*

Fish powder	1 kg
Onion	800 g
Coconut	400 g
Salt	to taste
Chilli	to taste
Ginger	to taste

Table 4. *Clinical signs on examination*

Open fontanelle	5%
Helminthic infestation	50%
Hair changes	20%
Stomatitis	5%
Oedema	2%
Pallor anaemia	57%

The nutritional status was assessed at 10, 20, 30 and 35th day of the study by recording the body weight and mid-arm circumference. Those children who were absent for more than two days in a week or those who failed to get 80% attendance were excluded. Children with massive helminthic infestation were dewormed. Positive results on deworming and any intercurrent illness or untoward symptoms of children were also recorded.

Results and Discussion

Only 75 children completed the programme with more than 80% attendance. The majority of parents were very poor (64% had a monthly income of Rs. 100/- to 200/- and 6.7% Rs. 300/- or more). About 60% of the parents had primary school education (upto 5th standard). 8% of fathers and 4% of mothers had passed S.S.L.C. examination. The study revealed that 57.3% of children had pyoderma or eczema, mixed with scabies earlier and 25.35% had measles.

Of the total 75 children who completed the feeding programme, 38 (50.66%) were boys and the rest girls. The age and sex-wise distribution are presented in Fig. 1. 96% of children were born after full term pregnancy and the rest were born prematurely (15 days earlier). 14.66% children exhibited pica (eating mud, dirt and charcoal). Pallor, suggestive of a moderate degree of anaemia was present in 57.6%. Other clinical signs are given in Table 4. Intercurrent infections in the form of asthmatic episodes, scabies and measles were noted in a minority of cases.

The cost of production on pilot plant scale of the fish powder worked out to Rs. 7/kg. The protein efficiency ratio (P.E.R.) of fish is 3.55 compared to 3.9 for egg, 3.09 for cow's milk, 2.30 for beef, whereas, soya, corn, ground nut, wheat and rice all have lesser P.E.R. (Shenoy *et al.* 1976). The P.E.R. of fish power used was 3.1 compared to casein (2.46). The amino acid composition of the fish powder is presented in Table 2. The loss of lysine after heating was the least in fish when compared to milk, ground nut or wheat. The role of supplementary feeding and the acceptance of low cost local

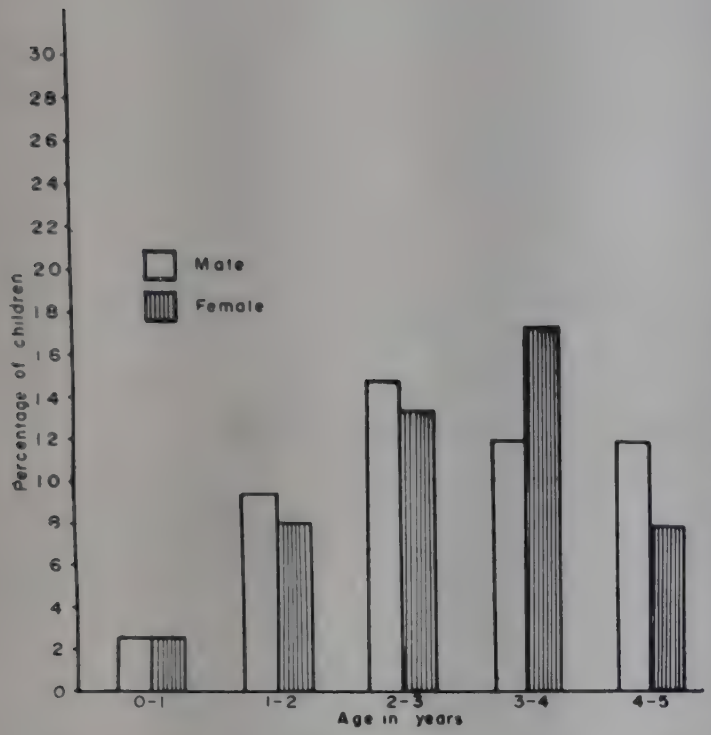

Fig. 1. Age and sexwise distribution of children

food served on the spot was also stressed by Kamaraj & Moorthy (1977).

The demonstrable improvement in the form of gain in weight and mid-arm circumference within a short period of 35 days, were quite impressive (Fig. 2). It was striking that no children developed diarrhoea,

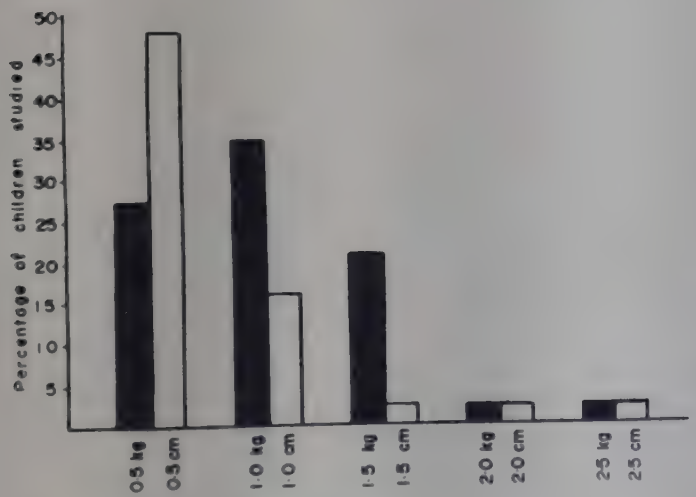

Fig. 2. Gain in body weight and mid-arm circumference

vomiting or any other gastro-intestinal disturbances, a clear testimony to the safe and hygienic nature of the preparation. The acceptability of the feed was excellent. Even children belonging to strict vegetarian families accepted the preparation without any inhibition. In the treatment of malnutrition and hypoproteinemia, this powder can be suitably modified and used according to regional food habits with promising results.

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Preparation of Masmin - An Improved Method

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An improved method for the preparation of 'Masmin' the traditional smoked tuna of the Lakshadweep is described.

Lakshadweep is well known for its rich tuna fishery. Almost the entire tuna landed here is converted by a special method into 'Masmin', a heavily smoked, hard-dried product. The method of preparation is very primitive so that the product lacks the qualities expected of it. Since the masmin industry contributes a major share to the economy of the islands and the product is esteemed as a delicacy in Sri Lanka, Singapore and Malaysia, improvement in the quality of the product is sure to find better acceptability and in turn improve the islands' economy. Valsan (1968) reported a method to control the insect attack in masmin. But no attempt has so far been made to standardise and improve the method of its preparation. This paper reports results of such a study. The traditional and improved methods are compared as regards the quality of the products.

Materials and Methods

Fresh tuna *(Euthynnus affinis)* was beheaded, cut open, guts removed, washed well and filleted longitudinally. The fillets were cut lengthwise into uniform strips of about 5 cm thickness and 15 cm length and washed in fresh water, divided into two equal lots and processed as described below.

Traditional method

Each strip was carefully wound round with green coconut leaves, boiled for 1 h in a mixture of sea water and fresh water (3:1) and left as such for about 12 h, then taken out, coconut leaves removed, spread on wire trays placed inside a smoking chamber and smoked for 12 h continuously using coconut husk and saw dust, dried in sun for about 6 h, smoked again for 6 h and dried to dark hard sticks.

Improved method

Strips prepared above were dipped in saturated brine (1 kg: 1 litre) for 30 min, taken out and exposed to steam for 1 h. The steamed strips were sun dried to about 40% moisture and then smoked for 4 h till the characteristic glossy appearance, brown colour and smoky flavour developed. The smoked strips were then dried to a moisture of about 10%. The products were analysed for chemical composition according to the methods of AOAC (1960).

Results and Discussion

Boiling in salt water followed by leaving the cooked meat in the liquid for a long time apparently results in greater concentration of salt in the meat and loss of nutrients as shown by the decrease in nitrogen factors (Table 1). Further, winding each strip with green coconut leaves to prevent the meat from breaking off during boiling is time consuming and laborious. This part of the process is conveniently avoided in the improved method with much less loss of flavour constituents.

Variations in the steaming process have been tried to determine the optimum stages of brining and steaming and their effects upon the quality of the product (Table 2). Brining followed by steaming gave the best results. After steaming, the strips were partially dehydrated to a moisture level of about 40% with a view to making the surface of meat to retain enough moisture

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Table 1. *Analytical characteristics of the product (Values in moisture and salt free basis)*

	Moisture	Ash	Sodium chloride (moisture free basis)	Total nitrogen	Amino nitrogen	Digestible nitrogen	Residual nitrogen	Remarks
	%	%	%	%	%	%	%	
Traditional product	6.8	8.1	7.6	10.61	0.1445	10.08	0.53	Dull dark colour, hardened crust on the surface, pungent smoky odour, highly salty, very hard, fibrous and difficult to chew
Improved product	10.2	9.5	1.6	11.94	0.5702	11.68	0.26	Uniformly dark brown appearance, mild smoky flavour blending very well with the characteristic fishy flavour, moderately hard, soft to chew and mild salty taste

Table 2. *Variations in the steaming process and their effect on the quality of the smoked product*

Type of process	Appearance	Flavour	Taste	Remarks
1	Good, uniform dark brown colour	Mild smoky flavour blending very well with the characteristic fishy flavour	Moderately salty, soft to chew	Excellent
2	Not good, dark ash colour with stray white patches on the surface	Predominantly smoky flavour masking the fishy flavour	Prominently salty with smoky taste	Good
3	Not good, very dark appearance	Not good, prominent smoky flavour	Highly salty, bitter taste	Poor

1. Dipped in saturated brine for 30 min and then steamed without pressure for 1h
2. Immersed in 15% brine and steamed for 1 h without pressure
3. Steamed for 1 h without pressure and then brined for 30 min in saturated brine

to absorb smoke vapours and produce the characteristic flavour and dry enough to allow the smoke components to react with the surface protein to produce the desired colour. Ruiter (1979) observed that hot smoking gives rise to ideal colour, flavour and glossy appearance if the moisture content of the sample is less than 65%. In the conventional process there is no pre-drying of the meat and the product acquires a dull dark appearance after smoking. Excessive interaction between smoke components and surface proteins inhibits the penetration of smoke constituents. As a result, the sub-surface remains unsmoked, soft and susceptible to rapid degradation, while the surface develops a hardened crust with a pungent smoky odour as in the case of the traditional product. Hence smoking time was limited to 4 h, during which the product acquired a glossy appearance, characteristic brown colour and the desired flavour.

The smoked product can be dried in sun or in artificial dryers to a moisture level of 10%. It is usual in the traditional process to dry the product hard till it reaches almost the consistency of wood. Heavy smoking followed by hard drying significantly alters the composition of the protein fraction of the meat. This contributes to the comparatively high amount of non-digestible form of protein and low quantity of amino nitrogen in the traditional product. Leaching out during cooking and subsequent holding in the brine also may be the causative factors for the latter phenomenon.

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Survey of the Properties of the Master Cartons (Corrugated Fibreboard Boxes) Used in Frozen Shrimp Industry

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Master cartons for fishery products collected from different prawn freezing factories were evaluated for bursting strength, puncture resistance, waterproofness, combined weight of liners, basis weight of the corrugating medium, weight of the carton, dimensions of the carton, wax content and saponifiable matter and discussed in the light of the ISI standards

India has of late emerged as one of the leading fishing nations of the world, ranking sixth in the magnitude of production, the annual fish landings touching a figure of 2.4 million tonnes. In the year 1979, India exported 78,976 tonnes of frozen prawns, fish and cuttle fish together (Anon, 1980) employing 3.95 crores of waxed duplex cartons and as many as 3.95 million corrugated fibreboard boxes. This gives some idea of the magnitude of this packaging industry. Frozen blocks weighing 2 kg are first packed in waxed duplex cartons lined with 100/125 guage low density polythene sheet. Ten such waxed cartons are packed in 5 ply corrugated fibreboard boxes which serve as shipping containers. These are strapped with 12 mm wide high density polythene or polypropylene straps.

Two of the common defects reported in the master cartons exported from India are low mechanical strength and tendency to get wet. They are weakened easily by deposit of moisture caused by temperature fluctuations during loading, unloading and other handling stages. As a result the master cartons appear soggy and often give way during handling (IS:6715–1972). The gross weight of the contents packed in master cartons lies between 20 and 30 kg. Among several packaging materials used in fishery industry, ISI specifications have been formulated only for corrugated fibreboard boxes for export of frozen seafoods and froglegs.

The present study deals with an extensive survey of master cartons used in the packaging of frozen fishery products as shipping containers with respect to their mechanical and chemical properties and their conformity to ISI standards.

Materials and Methods

Master cartons used in frozen shrimp export were collected at random from 32 different factories in and around Calicut, Cochin, Quilon, Bombay, Kakinada and Veraval. They were tested for different parameters as per ISI specification (IS: 6715–1972). The samples were conditioned before testing by the method described in IS : 1060 (1966). Bursting strength and water proofness expressed in terms of Cobb 30' value were determined as per the same Indian standard. Puncture resistance, combined weight of liners and corrugating medium were determined according to IS : 4006 (1972). The wax content in the corrugated fibreboard was determined by the method of IS: 3962 (1967). This method determines the unsaponifiable matter in the carbon-tetrachloride extractable material. The difference between the total solids extracted by carbon-tetrachloride and the wax content has been reckoned as the saponifiable matter content. The type of flute was determined as specified in the IS : 2771 (1977). The weights, dimensions and the general appearance of the cartons were also taken into consideration.

Results and Discussion

The particulars of the master cartons collected from 32 different factories and studied are given in Table 1, the bursting

strength in Table 2, values of puncture resistance in Table 3, water proofness in Table 4 and analysis of the cartons for combined weight of liners in Table 5. Weights of substance are presented in Table 6, total weight of each carton in Table 7 and volumes in Table 8.

Table 1. *Particulars of master cartons*

Total number of cartons	32
Number of plies in the carton	5
Number of waxed cartons	14
Number of unwaxed cartons	18
Number of cartons with 'B' flutes	31
Number of cartons with 'B' + 'C' flutes combined	1
Wax %	1.3 to 6.6
Saponifiable matter %	0.02 to 2.85

Table 2. *Bursting strength of master cartons*

Bursting strength kg/cm²	Cartons falling in each range
8.5– 9.5	11
9.6–10.5	6
10.6–11.5	5
11.6–12.5	6
12.6–13.5	1
14.0–16.5	3

Table 3. *Puncture resistance of master cartons*

Puncture resistance beach units	Cartons falling in each range
124–149	1
150–174	7
175–199	8
200–224	11
225–249	4
250–274	–
275–299	1

Table 4. *Water proofness of master cartons*

Water proofness Cobb 30′ value	Cartons falling in each range
60–120	3
121–321	17
322–522	8
523–723	1
724–924	3

Table 5. *Analysis of combined weight of liners*

Combined weight of liners g/m²	Cartons falling in each range
300–349	1
350–399	10
400–449	10
450–499	5
500–549	4
550–599	1
600–649	1

Table 6. *Weight of substance for corrugating medium in the master cartons*

Weight of substance g/m²	Cartons falling in each range
102–117	2
118–133	11
134–149	8
150–165	6
166–181	3
182–197	2

Table 7. *Total weight of master cartons*

Total weight g	Cartons falling in each range
550–600	5
601–651	11
652–702	8
703–753	1
754–804	3
805–855	4

Table 8. *Volume of master cartons.*

Volume cm³	Cartons falling in each range
23,100–25,000	1
25,100–27,000	1
27,100–29,000	2
29,100–31,000	7
31,100–33,000	14
33,100–35,000	7

It may be seen from Table 1 that no uniformity is maintained by the different manufacturers as regards waxing, quantity of wax employed wherever waxing is resorted to and in the saponifiable matter, which is usually resin, a sizing agent used in the manufacturing process of the paperboards which imparts water proofness to them. In general the flute that is being used in the corrugating medium is of the B type (40–55 corrugations/30 cm) and 2.1 to 2.9 mm flute height. Only one manufacturer has used a combination of B+C flute. 'C' flute contains 36–44 corrugations/30 cm and 3.6 to 3.8 mm flute height. It is seen from the results that only some manufacturers wax the master cartons. Waxing is necessary to reduce the water absorption and assists in the retention of various physical properties so that the strength of the carton is not reduced even while subjected to waterspray/condensation while shipping. The data shows that there is a variation in the wax content ranging from 1.3 to 6.6% and saponifiable matter from 0.02 to 2.85%. Waxing alone is not sufficient to reduce the water absorption value. Some percentage of saponifiable matter (usually rosin) and probably other sizing materials should also be present in the paper in order to keep it down. However, ISI specifications (IS: 6715–1972) do not lay down any minimum requirements for these constituents in the carton material. Probably, the requirement for water proofness stipulated in the standards takes care of this aspect indirectly, since in the absence of the required degree of glazing and probably external water proofing (by wax treatment) the former cannot be achieved.

It is observed from Table 2 that only 9.4% of the cartons studied conformed to ISI standards with respect to bursting strength, minimum value of which stipulated for cartons meant for holding 20–30 kg of material being 14 kg/cm². Bursting strength is a complex function of tensile strength and stretch. It reveals the interfibre bonding and the formation of paper, the latter meaning the uniformity with which fibres are distributed in the paper. The larger number of the cartons falling in the lower ranges of bursting strength contribute to the low mechanical strength generally reported in the commercial samples of master cartons.

Indian Standard Specification for puncture resistance of master cartons under study is 200 beach units. One half of the samples tested satisfied this condition and another 25% were within 25 units below the minimum value fixed. The puncture resistance is reflective of the paperboard quality. The resistance of paperboard to puncture is of extreme importance in the manufacture of shipping containers because of the hazards involved in transportation, handling and storing. Containers are frequently punctured by corners of other containers, lumbers, forks etc.

Cobb test is the test to measure the water absorption of the paper board. It reflects the efficiency of sizing and similar properties of paper and is particularly useful in assessing the suitability of corrugated fibreboards for the manufacture of master cartons to be used as shipping containers under conditions where they are likely to get exposed to waterspray or subjected to water vapour condensation. Cobb value must be low when the paper is used for making shipping containers which are subjected to high humidity for a prolonged period. Table 4 shows that only 9.4% of the cartons used in frozen shrimp export are conforming to the ISI standard of 120 Cobb 30′, some samples showing values as high as 6 to 7 times the maximum stipulated. It is interesting to note that lower Cobb values are generally associated with higher wax and saponifiable matter (rosin) contents. The sample which had a wax content of 6.46% and saponifiable matter of 2.85% showed the lowest Cobb value (68.25) among the samples studied. Another one with 4% wax and 2.27% saponifiable matter had a Cobb value of 91.77. However, this was not so always, for example, a sample with no wax coating and 0.43% saponifiable matter showed a Cobb value of only 11.5 and another one, also with no waxing, but with 0.82% saponifiable matter had a Cobb value of 138.3. This means that some other sizing agents used in manufacturing process of the board also influence the water resisting property. Hence the proper degree of sizing at the manufacturing stage and a superficial coating with wax help in enhancing the water proofness of corrugated fibre board.

It is seen from Tables 5 and 6 that only

18.8% of the samples studied conformed to the ISI specification of a minimum of 500 g/m² of combined weight of liners, while 34.4% satisfied the stipulation of a minimum of 150 g/m² for the corrugating medium. The basis weight is a very important property of paper and paperboards as they are customarily bought and sold on a weight basis but are used on area basis. It also affects the burst factor and other physical properties of board and the functional characteristics of the box. Besides, the basis weight can be used to a reasonable extent as an index of physical strength. Particularly in the case of shipping containers the basis weight has found a place in national and international specifications which are used as a guide by buyers in package design.

The weight of the carton is related to the grammage of paper, type of adhesives and dimensions of the box. Most of the cartons are having the weight in the range of 550–699 g (Table 7). The weight cannot be specified to the manufacturer as it may increase if the adhesive used is silicate based. This may be the reason why the ISI standards also do not stipulate any weight specifications for the corrugated fibreboard master cartons.

Table 8 shows that there are wide variations in the dimensions of the master carton. This is due to the variation in the dimensions of waxed duplex cartons (which are specified by the importers) used inside the master cartons whose dimensions have to be adjusted to exactly pack 10 numbers of the former. That may be the reason why the ISI specifications do not stipulate any restrictions on the dimensions of the master cartons. Nevertheless, dimension is an important property when exported to different countries as variation may affect the handling conditions. It is desirable to have the uniform dimensions in the duplex and master cartons for the same gross weight of the contents. In cases where automatic erection and filling of the boxes are envisaged, uniformity of dimensions has to be adhered to atleast with not more than ± 1 mm deviation. It is desirable that no single dimension exceeds 50% of the combined internal dimensions, that is, the sum of length, width and depth. A proportion of 2:1:1 is desirable to facilitate stacking and palletization.

It may be seen from the above that only 9.4% of the samples studied conformed to the ISI standard with respect to two of the most important criteria, namely, bursting strength and Cobb value, while the minimum requirement for combined weight of liners was met by only 18.8% of the samples, the latter may be the reason for the low bursting strength observed. More attention may have to be paid by the manufacturers of fibreboards/cartons for adhering to the quality parameters. It is also possible that some of the stipulations in the ISI standards may be too stringent for easy compliance. Probably, a certain amount of relaxation in these criteria is called for, paying due consideration to the safety of the material packed in the containers and the protective properties demanded of them for withstanding the rigors of transportation under normal commercial conditions obtaining in the country.

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Survey of the Properties of Waxed Duplex Cartons Used in Frozen Shrimp Industry

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Waxed duplex cartons collected from different prawn freezing factories were evaluated for their physico-chemical properties such as bursting strength, puncture resistance, water proofness, tearing strength, tensile strength, elongation, moisture content, thickness, weight of the carton, dimension, wax content and saponifiable matter. The results are discussed from the point of view of formulation of standards for this most widely employed packaging material for frozen fishery products in the country.

Proper packaging for frozen fish is essential for controlling the detrimental effects of oxygen and desiccation by barring the entry of air and escape of moisture. Another property to be looked into is its capacity to protect the contents from flavour contamination, entry of microorganisms, mechanical damage and exposure to light. Folding paperboard (duplex board) carton is the most important primary package used in the export of frozen sea foods. These cartons are given a wax coating for protection of the contents from loss of moisture. The material used for the purpose is a solid bleached sulfate board. Frozen blocks weighing 2kg are packed in such cartons lined with 100/125 gauge low density polythene sheet. Ten such waxed cartons are in turn packed in 5 ply corrugated fibre board boxes which serve as shipping container. About 4 crores of waxed duplex cartons are used annually by the frozen fish export trade in India. ISI specifications have not been formulated for this widely used packaging material for frozen sea foods and froglegs. The present study deals with an extensive survey of the waxed cartons used in the packaging of frozen fishery products as a primary package with respect to their mechanical and chemical properties.

Materials and Methods

Waxed cartons used in frozen shrimp export as a primary package were collected at random from 36 different factories in and around Calicut, Cochin, Quilon, Bombay, Kakinada and Veraval. They were tested for bursting strength, puncture resistance, tensile strength, tearing strength (both in machine and cross directions), elongation, moisture content, thickness, weight of the carton, dimension, wax content, saponifiable matter and water proofness. The samples were conditioned before testing by the method of IS: 1060 (1966). Moisture was determined by drying the sample in an oven at 100°C. Bursting strength and water proofness expressed in terms of Cobb 30′ value, thickness, tearing strength in both machine and cross directions, tensile strength and elongation were determined as per the IS mentioned above. Punture resistance was determined according to IS: 4006 (1972). The wax content was determined by the method in the appendix B of IS: 3962 (1967).

Results and Discussion

Variations of moisture in 36 waxed cartons are summarised in Table 1. Values of bursting strength in kg/cm² are shown in Table 2 and those of puncture resistance in beach units in Table 3. Water proofness of the samples expressed in terms of Cobb 30′ value is presented in Table 4. The values of tensile strength expressed in terms of kg f/1.5 cm width/18 cm length and elongation expressed in terms of increase in length are presented in Table 5. Results of analysis of cartons for wax content and saponifiable matter are given in Tables 6 and 7. Tearing strength both in machine and cross directions are presented in Table 8.

Total weight of each carton was recorded (Table 9), thickness of the carton (Table 10), and volume (Table 11).

It may be seen from Table 1 that there is considerable variation in the moisture of the cartons. Moisture in boards is a very important factor affecting physical strength, flexibility, sheet forming characteristics, weight, dimensional stability, rigidity, tearing strength, tensile strength, folding endurance and elasticity. Majority of the samples studied were found to have moisture between 8 and 10%. Very low moisture indicates the poor storage facility for these packaging materials in the factory. The higher the moisture, the poorer are the physical strength characteristics.

It is observed from Table 2, that 50% of the cartons are having bursting strength above 6 kg/cm². The waxed carton should have a bursting strength as high as possible so that it can withstand handling and storage conditions. It is seen from Table 3 that 67.4% of the cartons are having a puncture resistance above 26 beach units. The puncture resistance is reflective of the paperboard quality. Usually in the primary package the problem of puncture does not arise. It is encountered only during handling conditions by corner hit on the container before filling in the master cartons.

Table 4 shows that 80% of the waxed cartons are having Cobb value below 46. Cobb value must be low as the cartons are likely to come in contact with moisture in the frozen storage due to water condensation. It is interesting to note that low Cobb values are associated with higher wax and saponifiable matter (rosin) contents. The sample which had 6.84% wax and saponifiable matter of 5.4% showed the lowest Cobb value, namely, 2.84 among the samples studied. Another one with 9.65% wax and 2.5% saponifiable matter had a Cobb value of 6.112. A third one with 1.99% wax and 6.55% saponifiable matter had a Cobb value of 4.65. This shows that with a higher saponifiable matter and less wax, low Cobb values can be achieved. But some amount of wax should be present in the carton as otherwise the frozen product sticks hard to it with any glaze water freezing in between. Hence the proper amount of wax and saponifiable matter should be present in the carton to achieve the desired Cobb value.

Table 5 shows the tensile strength of the carton and elongation expressed in terms of kg f/1.5 cm width/18 cm length and centimeters respectively. In food packaging operations, tensile strength of a flexible packaging material is important as it determines the resistance to rupture when subjected to pulling force. High tensile strength for packaging materials are required to hold heavy packaged items. The values in Table 5 indicate that majority of the cartons are having tensile strengths between 6.08 to 9.08 kgf/ 1.5 cm width/18 cm length. Only one out of 35 cartons is having tensile strength above 20 kg f.

Elongation property of a carton which is measured on the same machine as that for tensile strength, gives a measure of the toughness or resistance to rupture. Packages which are likely to undergo drops during distribution/processing require cartons of higher elongation. Table 5 indicates that one third of the cartons are having an elongation below 0.85 cm/18 cm length.

Table 1. *Moisture contents of the cartons*

Range of moisture %	Cartons falling in each range
6.7–7.7	10
7.8–8.8	17
8.9–9.9	5
10.0–10.6	4

Table 2. *Distribution of bursting strength*

Range of bursting strength kg/cm²	Cartons falling in each range
3.6–4.0	1
4.5–5.0	3
5.25–5.75	13
6.00–6.50	15
6.75–7.00	3
7.25–7.50	1

Table 3. *Puncture resistance of cartons*

Range of puncture resistance beach units	Cartons falling in each range
20.0–22.0	1
22.5–25.5	11
26.0–29.00	14
29.5–32.75	8
33.0–37.50	2

Table 4. *Water proofness of waxed cartons*

Range of water proofness Cobb 30′ value	Cartons falling in each range
2.84–24.65	19
25.00–45.75	10
46.00–66.00	5
67.00–84.95	1
406.15	1

Table 5. *Tensile strength and elongation of cartons*

Range of tensile strength kg f/1.5 cm width/18 cm length	Cartons falling in each range
6.08– 9.08	23
9.10–12.10	1
12.20–15.20	5
15.30–18.30	4
18.40–19.50	1
> 20 kg f	1
Range of elongation cm (increase in length)/18 cm	**Cartons falling in each range**
0.30–0.50	13
0.55–0.85	11
0.86–1.16	9
1.20–1.50	2
1.60–1.83	1

Table 6. *Analysis of wax content*

Range %	Cartons falling in each range
1.99– 3.99	1
4.00– 6.00	5
6.10– 9.10	24
9.15–12.15	5
12.20–12.75	1

Table 7. *Analysis of saponifiable matter*

Range %	Cartons falling in each range
0.09–2.09	11
2.10–4.10	19
4.20–6.20	4
6.30–8.30	1
8.40–9.40	1

Table 8. *Tearing strength of the cartons in machine and cross directions*

Range of tearing strength g	Cartons falling in each range	
	Cross direction	Machine direction
128–178	5	16
179–229	16	12
230–280	8	6
281–331	4	0
332–384	3	2

Table 9. *Total weights of cartons*

Range of weights g	Cartons falling in each range
63–71	17
72–77	10
78–83	7
84–89	1
90–96	1

Table 10. *Thickness of the cartons*

Range of thickness mm	Cartons falling in each range
0.3375–0.4000	12
0.4025–0.4650	14
0.4750–0.5385	9
0.5400–0.6025	0
0.6100–0.6475	1

Table 11. *Volumes of the cartons*

Range of volumes cm^3	Cartons falling in each range
2171–2500	22
2505–2905	12
2910–3310	1
3315–3523	1

It may be seen from Tables 6 and 7 that no uniformity is maintained by the different manufacturers as regards quantity of wax applied on the carton and the saponifiable matter. Variations in the wax may be attributed to wide differences in the temperature of the wax bath used, as most of the manufacturers do not employ thermostats to control the temperature. Properly waxed cartons possess the advantages of being liquid proof and reducing the water vapour transmission rate while controlling the danger of sticking when in contact with the freezer plate.

The internal tearing resistance is a very important property in packagings for foodstuffs especially when sharp edged products are packed, since even a slight tear in the material may result in the total failure of the packaging. Tearing strength is dependent on the orientation of the molecules or fibres in the packing materials. Table 8 shows that 58.3% of the cartons are having tearing strength below 229 g in cross direction, while 44% possess values below 178 g in machine direction.

The weight of the carton is related to the grammage of the paperboard and dimension of the box. Most of the cartons (75%) are having weights in the range of 63–77 g (Table 9). The weight may be specified to the manufacturers provided the dimension is maintained constant by all the processors.

Table 10 indicates that 72% of the cartons are having thicknesses below 0.465 mm, while the remaining had above 0.475 mm. Caliper or thickness is a very important quality in paperboards, since it determines almost all physical, optical and electrical properties of paper including stiffness.

The data presented in Table 11 shows that there are wide variations in the dimensions of the waxed cartons. This brings about variations in the dimensions of the master cartons. It is desirable to have uniform dimensions in the duplex cartons for the same gross weight of the contents.

The current mode of packing 2 kg blocks of frozen fishery products in the country is termed bulk/institutional pack, which the importing countries reprocess into smaller consumer packs. Hence high standards of quality are not insisted upon in such cartons, as long as the corrugated fibre board boxes in which they are packed reach the destination in good condition.

Nevertheless, it is imperative that certain minimum standards of quality are laid down for the waxed duplex cartons as the primary package. Moreover, a change over to consumer packs is absolutely essential for improving the economy of the frozen fish industry, in which case the packages have to play an important role as silent salesmen of the ware they contain, both in internal as well as external markets.

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Salinity and Survival of *Martesia striata* (Linn) in Cochin Harbour

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The effects of salinity variations on the survival of *Martesia striata* from Cochin Harbour are presented. It is observed that at least a few of the animals survive the low saline conditions during monsoon. Laboratory experiments showed the lethal salinity as 6‰ when animals acclimatised in 34‰ were subjected to abrupt changes in salinity. But acclimatisation to 17‰ salinity showed a downward shift in the lethal salinity to 4‰. The present observations indicate that *M. striata* is euryhaline and the extent of tolerance to lower salinities depends on the degree of acclimatisation.

Martesia striata (Linn) is one of the most common molluscan wood-borers of the Cochin Harbour which cause serious damage to underwater timber structures. Some aspects of the biology and ecology of this bivalve from the Cochin Harbour have been studied by Erlanson (1936), Balasubramanyan and Menon (1963), Cheriyan (1964), Balasubramanyan (1965, 1967), Nair (1965, 1966), Cheriyan & Cherian (1971, 1974). Nagabhushanam (1955) have studied the salinity tolerance of *M. striata* from the Waltair coast by conducting laboratory experiments on animals acclimatised to normal sea water. The effects of acclimatisation to different salinities are not covered in his studies. The present paper reports the effects of salinity on the survival of *M. striata* from the Cochin Harbour, acclimated to different salinities. Laboratory experiments were supplemented by field observations, as evaluation of the tolerance limits to salinity variations requires both information obtained in the field and under controlled conditions in the laboratory as pointed out by Kinne (1971).

Materials and Methods

Field observations were carried out in Cochin Harbour using short term and long term test panels of mango wood *(Mangifera indica)* as described by Cheriyan and Cherian (1971). Per cent mortality in the field during different periods was calculated after removing live and dead animals from the test panels. The specimens required for laboratory experiments were collected from the test panels as well as from other underwater timber structures during the post-monsoon period when the salinity was about 17‰ and during the pre-monsoon period when the salinity was about 34‰. The specimens collected during post-monsoon were acclimated in the laboratory in 17‰ salinity and those collected during the pre-monsoon in 34‰ salinity, for 10 days along with the timber in laboratory aquaria. The water in the aquaria was rich in phyto and zooplanktons and continuously filtered and aerated for one to two hours twice a day as described by Cheriyan (1967a). Two series of salinity tolerance experiments on the lines described by Nagabhushanam (1955) were carried out with animals acclimated at 17‰ and 34‰ salinities. Various dilutions of sea water for tests were prepared by adding adequate quantities of re-aerated distilled water. The animals were carefully removed from the timber and healthy ones of 10-25 mm length were selected. They were thoroughly washed with water of the same salinity to which they were later to be transferred. In the first series, the animals acclimated in 34‰ salinity were subjected to 12 lower salinities ranging from distilled water to 34‰ (control). In the second series animals acclimated in 17‰ salinity were tested in 9 lower salinities including distilled water

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and 17‰ (control). For each test 200 ml of filtered sea water was taken in 500 ml beakers and 3-5 animals were transferred. 40–50 animals were tested in each salinity, the water changed and aerated every day. The animals were checked at short intervals during the experimental period of 14 days and no food was provided during this period. The animals survived in the laboratory without food for 5 weeks. The temperature was maintained at 28.5 ± 1°C. The animal was considered to be dead when the tip of the siphon no longer responded to mechanical stimulation. This was further checked by transferring it to the acclimatised salinity. Salinities where 50% mortality observed was considered as lethal.

Results and Discussion

Table 1 shows that during 1974 and 1975 about 30 and 21% of the animals, respectively, survived the very low salinity period of June-September (monsoon). During this period the surface water became almost fresh and at least 25% of the animals survived.

Animals acclimated in 17‰ salinity were directly placed in salinities 0, 1, 2, 4, 5, 6, 8, 10 and 17‰ (control). The results are presented in Table 2. When the animals were transferred to different test media, they closed their shell valves tightly. But gradually they opened the shell valves and extended the siphons. The time taken for the protrusion of the siphons in the different media varied from 5 to 30 min. the minimum in 17‰. 100% survival was noticed in 6–17‰ salinities. No survival noticed in 0‰ and 1‰ salinities at the end of the experiment. The lethal salinity noticed was 4‰.

M. striata acclimated in 34‰ were directly placed in salinities 0, 1, 2, 4, 5 6, 8, 10, 15, 20, 30 and 34‰ (control). The results are presented in Table 3. As in first series, the tightly closed shell valves opened gradually within about 30 min. The animals took minimum time to protrude the siphons in 34‰ and the maximum in 1‰. Survival was 100% in 20–34‰ and no survival in 0.5‰ at the end of the experiment. The lethal salinity was 6‰.

The hydrographical conditions in Cochin Harbour region are largely influenced by the monsoon and fresh water influx from a number of rivers. Studies in and around Cochin have shown that the temperature varies between 24–32°C while the salinity from fresh water condition to 34‰ (Cheriyan 1967b; Sankaranarayanan & Qasim, 1969; Cherian, 1978). Based on the salinity variations in the Cochin Harbour, three

Table 1. *Survival of M. striata on test panels immersed in Cochin Harbour during low salinity period (June to September)*

	Period	Average salinity ‰	Total Martesia	Number of live Martesia	Percentage of live Martesia
1974	June	25.5			
	July	1.9	13	8	61.5
	August	0.9			
1974	June	25.5			
	July	1.9	20	2	10.0
	August	0.9			
	September	13.9			
1975	May	30.2			
	June	20.7	24	5	20.8
	July	0.3			
1975	June	20.7			
	July	0.3	10	2	20.0
	August	2.6			
	September	5.0			

Table 2. *Per cent survival of of M. striata transferred to various salinities after acclimation in 17‰*

Days	Salinity ‰ 17–6	5	4	2	1	0
1	100	100	100	100	35	25
2	100	100	90	50	10	5
3	100	90	90	20	5	0
4	100	90	50	10	0	0
5	100	90	50	10	0	0
6	100	90	50	10	0	0
7	100	90	50	10	0	0
8	100	90	50	10	0	0
9	100	90	50	10	0	0
10	100	90	40	10	0	0
11	100	90	40	10	0	0
12	100	90	40	10	0	0
13	100	90	40	10	0	0
14	100	90	40	10	0	0

periods can be distinguished namely, the monsoon (June–August), the post-monsoon (September–December) and summer (January–May). Owing to freshwater influx the monsoon is characterised by salinity often below 1‰. During the post-monsoon the salinity gradually rises and the area attains typical marine conditions in summer.

Cheriyan (1964) and Nair (1965) have observed that in Cochin Harbour the settlement of *M. striata* is seasonal, restricted to the summer months January–May. Cheriyan & Cherian (1971) reported that the attack of *M. striata* begins as early as December and continues till May with maximum intensity in March–April, when salinity is maximum. Since the temperature variations of this region are not much, it is presumed that the settlement of *M. striata* is largely dependent on salinity. *Martesia* being marine, may not breed in the low saline period of June–November. Moreover in these conditions even if some larvae from the adjoining sea enter the harbour, they may not survive. The salinity is usually above 20‰ from December onwards and this period is tolerable to the young ones.

Field observations have revealed that most of the stenohaline sedentary organisms that settle during the high saline period perish during monsoon. But an average of 25% of the population survive the low saline period of June–September (Table 1) and propagate when the salinity becomes favourable. The fresh settlement of *M. striata* in the harbour region from December onwards may not be entirely by larvae entering the estuary from the adjoining sea.

Table 3. *Per cent survival of M. striata transferred to various salinities after acclimation in 34‰.*

Days	Salinity ‰ 34–20	15	10	8	6	5	4	2	1	0
1	100	100	100	100	100	100	80	80	30	20
2	100	100	100	100	100	80	80	0	0	0
3	100	100	100	90	80	50	0	0	0	0
4	100	100	100	90	80	50	0	0	0	0
5	100	100	100	80	70	50	0	0	0	0
6	100	100	100	80	70	30	0	0	0	0
7	100	100	90	80	70	30	0	0	0	0
8	100	90	90	80	60	20	0	0	0	0
9	100	90	90	80	60	10	0	0	0	0
10	100	80	70	70	60	0	0	0	0	0
11	100	80	70	70	60	0	0	0	0	0
12	100	80	70	70	40	0	0	0	0	0
13	100	80	70	60	40	0	0	0	0	0
14	100	80	70	60	30	0	0	0	0	0

Kinne (1971) observed that acclimation to low salinities tends to shift the lower lethal limit further downward. Laboratory experiments on *M. striata* acclimated in 34‰ showed the lethal salinty to be 6‰, when subjected to abrupt changes in salinity (Table 3). Nagabhushanam (1955) has also reported 6‰ as the lethal salinity. Field observations showed that at least a few withstand even near freshwater conditions (Table 1). This may be due to the fact that the area attains fresh water conditions only within the course of a few days of heavy rains which may be sufficient for the animals to slowly acclimatise. The present observations indicate that *M. striata* can tolerate low salinities depending on the degree of acclimation and since Remane (1958) has included those animals which tolerate salinities below 15‰ in the euryhaline group, this species can be also called euryhaline, if not truly estuarine.

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Protein Concentrate from Shark

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A simple method of leaching the minced muscle with water repeatedly followed by cooking, pressing, drying the cake and powdering has been described for the preparation of fish protein concentrate (FPC) from shark without the use of solvents. The FPC thus prepared had a high protein content and was completely free of urea. It contained all the essential amino acids in a balanced proportion with a high lysine content and had a storage life upto 12 months. This product can be used for the fortification of bread, biscuits and 'chappathis' respectively at 10, 5 and 2% levels.

A large proportion of the population in the developing countries suffers from malnutrition including protein deficiency as they subsist on starchy foods of poor quality and low protein content. One way to combat the problem of protein gap is to tap the fishery resources of the seas around us, which according to experts are very much under-exploited at present. Fish proteins are highly nutritive and fairly well balanced with respect to the essential amino acids and rich in lysine unlike most cereals and other staple food items. Supplementation of starchy foods with fish and fishery products even at low levels, greatly improves their overall growth promoting property. Being a highly perishable commodity, fish has to be processed and utilised as a source of animal protein, if not consumed immediately in the fresh state.

Drying, salting and drying, ensiling or preparation of hydrolysates, sauces and pastes are some of the methods of processing fish for long term preservation. Another method of using fish for supplementing the cereal diet would be to convert them, especially the low priced varieties, into fish flour or fish protein concentrate (FPC). This can be conveniently used, stored for long periods and has a high protein content of good biological value. This paper deals with the preparation of FPC from shark, its nutritive value and storage characteristics.

Materials and Methods

Shark *(Carcharias sp.)* was used for the study in view of its fair availability, characteristic white meat and low fat content. The protein content in the edible portion of the wet fish is high (21.59%) and the fat is 0.42% on a moisture basis of 75.95% (Chari, 1948). Flesh was separated from the fish, urea removed and used for the preparation of FPC. The urea-free material was cooked in water for 15 min, pressed, dried in air oven at 60-65°C, pulverised, kept sealed in polythene bags at ambient temperature and storage life studied over a period of one year.

Moisture, crude protein, fat and ash were determined according to AOAC (1960). Urea was estimated using the water extract of the fish or the FPC with urease solution in phosphate buffer of pH 6.2 by the Conway microdiffusion method (Conway, 1947) and the total volatile base nitrogen (TVBN) by the microdiffusion method using water extract. The amino acid analysis of FPC was done by microbiological assay (Shockman, 1963).

Results and Discussion

The flesh of sharks possesses a peculiar odour and flavour which is largely attributed to various non-protein nitrogenous constituents occurring to the extent of about 30% of the total nitrogen (Velankar & Govindan, 1958). Urea is a major constituent of the non-protein fraction and its elimination from the flesh is desirable before proceeding to prepare FPC. Earlier methods of removal of urea from shark, namely, salting out (Kandoran *et al.*, 1965) and acetic acid treatment (Revankar *et al.*, 1965) were not

Table 1. *Removal of urea from shark muscle*

	Urea per cent		Urea reduction %
	Initial	After treatment	
Fillets kept in water for 30 min at room temperature with intermittent stirring	1.62	0.875	45.98
Fillets kept in water for 30 min at 10°C with intermittent stirring	1.62	0.950	42.10
Fillets in 5% solution of jackbean powder	1.62	0.471	71.20
Fillets in 5% solution of horse gram powder	1.77	0.494	72.22
Fillets boiled in water twice for 10 min	1.22	0.064	94.75
a) Minced flesh kept in water for 15 min at room temperature with intermittent stirring	1.07	0.192	82.17
b) Minced flesh kept in water for 15 min at room temperature with intermittent. The above repeated for the second time	1.07	0.064	94.02
c) Minced flesh kept in water for 15 min at room temperature with intermittent stirring. The above repeated for the third time	1.07	Nil	100.00

tried in view of the introduction of NaCl to the product by the former process and slight acid taste in the case of the latter. Enzymatic removal of urea from the flesh was tried using horse gram and jack bean flour preparations. Since urea is water soluble, leaching of the muscle with water in the fillet form and in the minced form was tried. The results are presented in Table 1. In the case of fillets, the removal of the urea by simple soaking in water at room temperature or at reduced temperature was only upto 46%. But boiling the fillet twice had a pronounced effect and urea could be brought down to 94.75%. Enzymatic removal of urea from shark fillet was only upto 72%. It can be seen from Table 1 that 94.02% of the urea was removed by keeping and stirring the minced muscle of the shark in water twice and complete removal was achieved by repeating the treatment for a third time.

The methods of preparation of FPC using solvent extraction do not remove the lipids and odoriferous compounds completely and their last traces are very difficult to be removed at the end of the process. They also form toxic compounds or destroy some amino acids in the material (Moorjani & Lahiry, 1962; Morrison & Munro, 1965). In our studies, urea free minced shark flesh was utilized for the preparation of FPC and no solvent was used for the removal of lipids.

The yield of FPC prepared using urea-free minced muscle was 16% on the basis of the shark flesh and the chemical composition of FPC is given in Table 2. The FPC was almost white in appearance with high protein content. Fat content has not been reduced to any appreciable extent probably because no solvent extraction has been attempted to. But when compared

Table 2. *Chemical composition of FPC*

Moisture %	5.54
Crude protein %	87.60
Fat %	1.03
Ash %	2.09
Urea %	Nil

Table 3. *Essential amino acid composition of FPC*

Amino acids	% of N x 6.25
Isoleucine	6.10
Leucine	9.11
Lysine	7.37
Methionine	3.01
Cystine	0.70
Phenylalanine	4.82
Tyrosine	2.90
Threonine	4.11
Valine	6.11
Tryptophan	0.91

Table 4. *Storage characteristics of FPC*

Period of storage months	Moisture %	TVBN mg/100g	Organoleptic score
0	5.5	2.7	15
1	5.2	4.5	15
2	5.7	4.9	15
3	5.5	8.2	15
6	5.8	7.7	14
9	5.6	7.9	14
12	5.9	11.2	13

Score: colour 5, odour 5, flavour 5, total 15

to FAO specification of 0.75% for "Type A" FPC (Protein Advisory Group 1971) about 1% fat in the shark FPC may not be objectionable especially when it is to be used for fortification of other foods. The essential amino acid composition of the FPC is given in Table 3.

The FPC kept well for a period of one year (Table 4). There was no deterioration in the odour and flavour but for slight yellow discolouration appearing in the product. Air tight storage coupled with low moisture and fat contents have contributed to the preservation of the product over a long period.

FPC is generally used for protein supplementation of foods and is not consumed as such. It was used in the preparation of biscuits, bread and 'chappathis' at 2,5,7.5 and 10% levels in the flour mix and the products evaluated by a taste panel. Biscuits with FPC upto 5% did not reveal any change with respect to appearance or taste. Bread with 10% FPC showed no changes in loaf size and colour but a faint fishy odour was perceptible. In the case of 'chappathis' fortified with 2% and more FPC, the product had a darker appearance with pronounced flavour. Incorporation of FPC did not affect the normal storage of 'chappathis' at room temperature.

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Fat and Water Contents of the Muscle and Gonad of *Otolithus argenteus* in Relation to Gonad Growth

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Fat and water contents of the muscles and gonads in relation to gonad growth in *Otolithus argentes* from Karwar are reported. Water content showed an inverse relationship to lipid in both the sexes. Variation in somatic body weight was found associated with the fluctuations in lipid contents.

In fishes, the nutrients for germinal tissue growth may be drawn from somatic tissues. Earlier investigations (Masurekar *et al.* 1977; Pandey *et al.* 1976; Hickling, 1947; Idler & Bitness, 1960) showed that fat reserves stored in muscle, liver and intestine are transferred to the gonads during maturation. Recently, Medford & Mackay (1978) suggested that in order to measure the energy transfer from the body to the gonads, the amount of nutrients in the body and gonads must be determined at various stages of sexual maturity. Although some information is available on biochemical studies of fishes from India, very little attention has been paid to study such aspects in fishes of Karwar and the present paper reports the fat and water content of the muscles and the gonads in relation to gonad growth in *Otolithus argenteus*, an important edible fish of Karwar.

Materials and Methods

O. argenteus collected monthly from commercial catches at Karwar from November 1978 to October 1979 were cleaned, length and sex noted. The stage of maturity was determined following the classification of International Council of Exploration of the Sea (Wood, 1930). Individuals ranging in total length 26 to 28 cm were taken so as to reduce size dependent variability. 20–22 fishes in each sex were utilised for each analysis. For each fish, the stomach was emptied and gross body weight determined. Gonad was blotted dry and weighed. The somatic body weight was noted as the gross body weight without gonad and liver. The required samples were dried in an electric oven to constant weight to determine the water content. Extraction of lipid was effected by a modification of the method of Bligh & Dyer (adopted by Gopakumar, 1965) and the results are summerised in Tables 1, 2 & 3.

Results and Disscusion

In males, the somatic body weight fluctuated significantly. It was high and relatively stable from April to October with a peak of 250 g in May. It then decreased during the advanced maturing stages and period of spawning to 212 g. In females

Table 1. *Percentage lipid and water content (wet-weight basis) in muscle of O. argenteus*

	Female		Male	
Stage	Lipid	Water	Lipid	Water
1	14.64	70.82	11.18	76.03
2	4.67	82.03	6.05	79.40
3	13.24	72.18	11.12	75.26
4	12.25	73.04	10.04	76.17
5	7.79	78.87	8.15	78.57
6	8.47	78.12	9.62	76.76
7	2.70	83.14	3.37	81.82

Table 2. *Percentage lipid and water content (wet-weight basis) in gonads of O. argenteus*

	Female		Male	
Stage	Lipid	Water	Lipid	Water
1	2.87	82.17	4.58	80.30
2	3.24	81.35	5.02	79.50
3	7.75	76.17	7.34	77.60
4	14.55	70.04	9.06	76.41
5	17.46	68.40	13.68	71.80
6	17.90	68.09	14.40	70.10
7	2.07	86.59	3.60	84.10

Table 3. *Gonad weight of O. argenteus in different months*

Month	Male	Female
November	4.12	18.64
December	2.60	17.29
January	2.20	14.50
February	1.40	88.40
March	0.85	2.14
April	0.58	0.46
May	0.73	1.41
June	0.88	3.08
July	1.64	9.26
August	3.35	14.95
September	3.70	16.60
October	4.05	17.52

Gonad weight (g) calculated for 27.5 cm total length

the somatic body weight was relatively constant from April to October except in May when it reached 254 g. (Fig. 1). The lipid and water content in the muscle varied and was similar in sexes in each month. The pattern of fluctuation in the lipid content was the same as that of somatic body weight. The maximum concentration of lipid in both sexes were noted during the first stage, when it was 14.64% and 11.18% for female and male respectively. The lowest values were noted in the sixth stage. The water content varied in proportion to the changes in the lipid percentage (Table 1). Growth of the gonads commenced from April when the ovary and testis were 0.1 and 1.2% of the gross body weight and it was almost the same in both the sexes. Ovary weight reached the maximum, namely, 7% of the gross weight in November. About 14.5% of this increase was in April to June and the remainder in July to November, whereas, the testis contributed to 1.6% of the gross body weight in November, about 8.5% of which was noted in April to June and 91.5% in July to November. This lipid concentration of gonads increased gradually with maturation, culminating at sixth stage with 19.79% in females and 14.4% in males, while the lowest was 2.07% and 3.6% in females and males respectively during the spent stages. The water content showed an inverse relationship to lipid, in both the sexes.

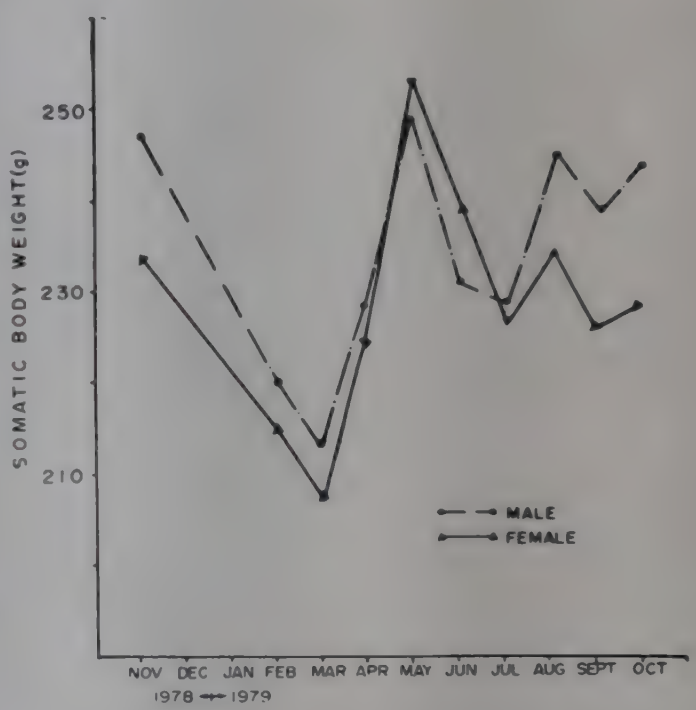

Fig. 1. Somatic body weight of *O. argenteus* in different months

Lipid accumulates in various organs prior to the maturation of gonads (Love, 1957). Bailey (1952) reported that in salmon and herring, the lipid is concentrated within and between muscle fibres. The use of muscle tissue as an energy source has been well documented in salmon (Idler & Bitness, 1958).

The variation in the somatic body weight is associated with the fluctuation of lipid composition. It may be noted that because of insufficient lipid reserves, endogenous

protein becomes more important than endogenous lipid as an energy substrate in the metabolism of fish (Medford & Mackay, 1978). The marked decrease in somatic body weight during spawning may be surmised as the result of catabolic activity of whole muscle tissue. It is interesting to note that the somatic body weight was almost the same in both the sexes during early stages of maturation. But the occurrence of low values of somatic body weight in females of *O. argenteus* during advanced maturity stages might be as a result of more nutrient requirement of the ovaries. Similar observations were made in other fishes (Chidambaram *et al.* 1952; Chrazan, 1950).

In the case of *O. argenteus* gonad weight increased with maturation. The ovary weight attained a maximum of 7% of gross body weight, which is higher than the weight of the testis. This increase in weight may be attributed to the accumulation of nutrients, especially of fat, to meet the additional energy requirements for the growth of the ovary. The body of the male contains generally more amount of fat than in female (Banerji & Bagchi, 1970). The depletion in the lipid content of muscles between ripe and spent stages in both sexes indicates that accumulated lipids are utilized during spawning (Masurekar *et al.* 1977). Thus, it gains support for the fact that feeding is poor or nil in matured fish, as Sekharan (1955) has found that the heavy feeding led to the accumulation of fat, in the muscles of *Trichiurus haumela*. The fluctuation in the percentage of water has only shown its inverse relationship, as it apparently reflects the fact that any lipids possess marked hydrophobicity, which effects the percentage content of water in the tissues. After reviewing the work of Luhmann (1963), Meyer (1958) attempted to prove the existence of greater correlation between fat content and gonad growth in herring. Our studies also showed the existence of such a correlation.

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NOTES

Isolation of *Salmonella roan* for the First Time in India

Of the outbreaks of bacterial food poisoning, salmonellosis remains one of the major ones. The genus *Salmonella* contains more than 2000 serotypes and in India alone 122 serotypes are described till now. (Saxena *et al.*, 1980). Every year new serotypes are being added to the list. Isolation of a new serotype, *Salmonella roan*, for the first time in India is reported in this communication. This serotype has not hitherto been reported from any of the sources in this country.

The serotype was isolated on October 19, 1977 at Cochin from a market sample of frozen froglegs intended for domestic consumption. The method suggested by AOAC (1975) was followed. Sixteen strains isolated were sent to the National Salmonella and Escherichia Centre, Kasauli, for serotyping. As these strains were suspected to be a new serotype, they were sent by the National Salmonella and Escherichia Centre, Kasauli to the International Salmonella Reference Laboratory at Paris, where, they were identified to be *Salmonella roan* (38:1v: enx). A final report on the isolation of this new serotype was received in July, 1978. The biochemical properties of *Salmonella roan* were similar to that of typical *Salmonella*.

The authors are highly thankful to the National Salmonella and Escherichia Centre, Kasauli and the International Salmonella Reference Laboratory, Paris for serotyping the strains. The authors are also grateful to Shri G. K. Kuriyan, Director and Shri M. R. Nair, Scientist of the Central Institute of Fisheries Technology, Cochin for encouragements.

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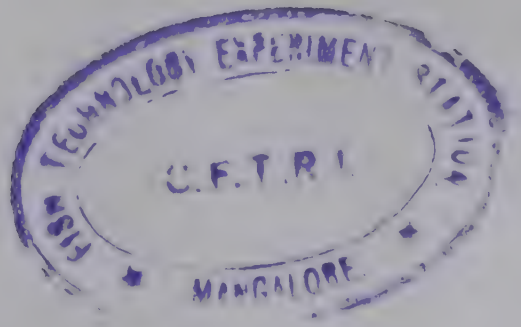

Fish. Technol. (1980) **17**, 125-126

Frozen Storage Characteristics of Ribbon Fish

Ribbon fish *(Trichiurus* sp.*)* is landed in larger quantities, especially along the Gujarat coast. At present the fish goes mostly for making low quality fish meal. Some general suggestions for its utilization as cured products have been reported by Devadasan & Venkataraman (1978). The frozen storage characteristics of ribbon fish in different forms are reported in the present communication.

Fresh ribbon fish procured from the local fish landing centre were cleaned, beheaded, gutted, washed well in potable water, cut into pieces of about 20 cm length and washed again. After draining, the fish was divided into 3 lots. One lot was frozen as blocks of 1 kg each (with 8–12 pieces of fish in each) in freezing trays, second lot was frozen after wrapping each piece individually in polythene paper, third one was carefully deboned, minced, frozen as blocks of 1 kg each at–40°C and stored at–18°C.

The fish was analysed for its chemical characteristics before and immediately after freezing and thereafter at regular monthly intervals. Moisture, total nitrogen (TN), total non-protein nitrogen (TNPN), water soluble nitrogen (WSN) and salt soluble nitrogen (SSN) were determined by the methods followed by Devadasan *et al.* (1978). Organoleptic evaluation was done by the method of these authors.

Table 1. *Chemical composition*

Moisture %	77.67
TN %	2.81
Lipids %	0.70
Ash %	1.18
TNPN %	0.48
WSN % of TN	31.10
Alpha amino nitrogen mg/100 g	38.00

Table 1 gives the proximate composition of fresh ribbon fish. Table 2 presents the changes in chemical and organoleptic characteristics of block frozen ribbon fish chucks during storage at–18°C. Changes in total nitrogen were not very significant during storage upto six months. However the amount of total non-protein nitrogen registered a steady decrease. Water soluble nitrogen showed a slow decrease upto 16 weeks. Salt soluble nitrogen registered a significant decrease after 16 weeks. The same trend was noted in amino nitrogen and also in the organoleptic score. Individually wrapped and frozen chunks did not show any appreciable difference from block frozen chunks. But they had a slightly better flavour and texture compared to the block frozen products (Table 3).

The frozen storage life of minced meat was lesser compared to frozen chunks. The frozen minced meat was good upto 12 weeks, after which the quality showed slight deterioration as reflected in the chemical and organoleptic values (Table 4).

The changes in ribbon fish during freezing and storage was thus found to be similar to the changes in other marine fishes. Freezing as chunks and individually wrapped in polythene is found to be the best method for its preservation, as it retained its quality upto 16 weeks. Even after 16 weeks, the product remained acceptable upto 28 weeks, though there was some loss in its original quality. Frozen minced meat of ribbon fish was acceptable upto 12 weeks only after which it showed marked signs of deterioration.

Table 2. *Changes in block frozen chunks*

	Storage in weeks						
	0	4	8	12	16	20	24
Moisture %	77.74	77.67	79.00	78.32	79.20	78.50	77.10
TN %	2.81	2.82	2.78	2.82	2.80	2.84	2.91
TNPN %	0.48	0.39	0.40	0.41	0.35	0.31	0.31
WSN % of TN	30.20	27.80	27.50	27.00	25.00	26.10	26.00
SSN % of TN	49.10	46.50	42.10	40.00	40.10	28.60	27.50
Alpha amino nitrogen mg/100 g	39.40	36.00	36.10	33.20	32.70	31.00	30.00
Organoleptic score out of 10	9	8	8	7	7	6	4

Table 3. *Changes in individually frozen chunks*

	Storage in weeks						
	0	4	8	12	16	20	24
Moisture %	77.42	76.56	78.12	77.30	78.52	78.00	78.10
TN %	3.09	2.90	2.85	2.80	2.87	2.83	2.82
TNPN %	0.47	0.43	0.41	0.38	0.32	0.32	0.31
WSN % of TN	31.10	30.80	28.70	27.70	—	26.76	26.80
SSN % of TN	48.20	40.30	39.10	42.15	41.00	30.85	29.00
Alpha amino nitrogen mg/100 g	33.30	40.50	37.40	36.50	35.50	28.00	27.80
Organoleptic score out of 10	9	9	8	8	7	5	5

Table 4. *Changes in frozen minced meat*

	Storage in weeks						
	0	4	8	12	16	20	24
Moisture %	78.92	78.10	77.52	77.20	76.32	75.92	75.15
TN %	2.83	2.92	2.87	2.76	2.84	3.00	2.81
TNPN %	0.46	0.41	0.39	0.37	0.37	0.36	0.36
WSN % of TN	29.30	27.80	25.20	26.10	—	24.60	25.10
SSN % of TN	58.50	50.35	41.10	38.80	34.60	36.80	33.00
Alpha amino nitrogen mg/100 g	35.80	34.60	32.90	28.40	25.00	24.80	25.10
Organoleptic score out of 10	9	8	7	6	5	4	4

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Preparation of Edible Powder from Jawla (*Acetes* sp.) Prawns

Inspite of the heavy landings of jawla prawns in Maharashtra, it fetches only very poor returns to fishermen. The present practice is to sun dry the whole prawn on the beach and is marketed as such. But the product is poor in appearance and unhygienic. Attempts to prepare edible fish flour were made by Pillai (1957), Moorjani *et al.* (1962) and Ismail *et al.* (1968). But they employed various solvents to remove fat. Solanki *et al.* (1977) prepared edible fish powder from dhoma meat without solvent extraction of fat. Garg *et al.* (1977) prepared protein powder from jawla prawn, by drying heat coagulated pulp in the sun and under vacuum.

Four methods were employed for the preparation of prawn powder in this study. In the first method fresh jawla prawns were thoroughly washed with potable water to remove slime and dirt and were spread in thin layers on shelves of a hot oven at 40°C. After 24-28 h drying, prawns were pulverized to a fine powder in a table mill and sieved using a sieve of 3600 meshes/sq. inch; moisture, protein, fat, ash and bacterial load of the powder were determined. In the second method, prawns were washed and oven dried at 60°C for 8-10 h, pulverized to a fine powder and studied as described above. In the third method the washed jawla prawns were beheaded, washed again and oven dried at 40°C for 24-28 h and powdered. In the fourth method the sun dried prawns procured from the market were dried for 4-6 h in oven at 40°C and used.

The analytical characteristics and bacteriological quality of the edible powders are presented in Table 1. The first method gave good quality powder, followed by method 2. Powder prepared from beheaded prawns was found to be very good but the beheading was time consuming with lesser yield. In the case of sun dried jawla prawns procured from the market high counts of viable bacteria and coliforms were noticed. Preparations of prawn spirals, prawn khabab, prawn puris and prawn wafers with powder obtained under method 1 and 2 were satisfactory. The preparation of powder is simple and hygienic with little

Table 1. *Proximate composition and bacterial quality of prawn powder prepared by different methods*

Method	Crude protein %	Ash %	Fat %	Moisture %	Total plate count/g	Coli-forms/g	Salmo-nella/g
1	61.25	19.60	6.50	15.66	40.5×10^4	Nil	Nil
2	66.50	17.40	6.20	12.26	40.0×10^4	Nil	Nil
3	63.73	17.20	4.03	12.70	30.0×10^4	2	Nil
4	60.60	18.78	10.50	15.66	30.0×10^4	20	Nil

alteration in protein. The low cost and easy availability of jawla prawns are added advantages of using it for the large scale preparation of powder.

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